ARMY

Submission of Proposals

The responsibility for the implementation, administration, and management of the U.S. Army Small Business Technology Transfer (STTR) Program rests with the Army STTR Program Management Office at the U.S. Army Research Office (ARO). You are invited to submit STTR proposals to ARO at the address below. Proposals must be received at this address no later than the required solicitation closing date and hour.

U.S. Army Research Office
ATTN: STTR-98 (LTC Jones)
P.O. Box 12211
4300 South Miami Blvd.
Research Triangle Park, NC 27709-2211

The Army has identified four technical topics, numbered ARMY 98T001 through ARMY 98T004, to which small businesses and their partner research institutes may respond. Only proposals addressing these topics will be accepted for consideration for Phase I of the STTR Program.

The Army anticipates sufficient funding to allow award of one to three STTR Phase I contracts to firms submitting the highest quality proposals in each topic area. Awards will be made on the basis of technical evaluations using the criteria contained in the solicitation within the bounds of STTR funds available to the Army at the time of award. If no proposals in a topic merit award relative to the proposals received in other topics, the Army will not award any contracts for that topic.

Proposals for Phase I are limited to a maximum of $100,00 over a period not to exceed six months.

Any Phase II contracts resulting from Phase I proposals submitted for this solicitation will be limited to a maximum of $500,00 over a period of two years. Phase II contracts will be structured as a single year contract with a one year option.

Department of the Army
Small Business Technology Transfer Program Solicitation
Topic Titles FY 1998

ARMY98-T001 Magnetic Resonance Force Microscopy

ARMY98-T002 Real-time, Two-Dimensional Terahertz Wave Imaging

ARMY98-T003 Catalysis of Technologically and Environmentally Significant Processes

ARMY98-T004 Distributed Interactive Agents

Department of the Army
FY 1998 STTR Topic Description

ARMY98-T001 TITLE: Magnetic Resonance Force Microscopy

KEY TECHNOLOGY AREA: Materials, Processes and Structures (DTA-15)

OBJECTIVE: Design, construct and operate a magnetic resonance force microscopy capable of in-situ detection of individual magnetic moments (single electron or nuclear spins), and three dimensional mapping of their position with subangstrom spatial resolution.

DESCRIPTION: Identify an integrated approach to the construction of a magnetic resonance force microscope, which will have sufficient sensitivity to detect a single electron spin. The emphasis is on exploring both hardware and software innovations that will significantly advance the technology with respect to the current state of the art. Proposals should include the construction and demonstration of a prototype system. Approaches that offer the prospect of eventually providing single nuclear spin detection will be given highest priority.

PHASE I: Investigate and demonstrate the feasibility of developing a magnetic resonance force microscopy with sufficient sensitivity to detect a single electron spin.

PHASE II: Implement the innovation, which shall include the design and testing of prototype systems. Extend the research to determine whether single nuclear spin detection is feasible. Explore major cost and reliability issues associated with the technology in the context of commercial viability.

PHASE III DUAL USE APPLICATIONS: Magnetic resonance force microscopy offers the capability of mapping the composition and crystal structure of a material at angstrom spatial resolutions. This capability has broad commercial and military utility including: advanced semiconductor device research (e.g. individual impurity and defect characterization), single molecule analytical chemistry, infectious disease research, and new solid state physics research (e.g. investigations of electron spin coupling mechanisms and quantum computational physics). This research is intended to introduce a new analytical instrument that affords single atom detection and resolution.

ARMY98-T002 TITLE: Real-time, Two-Dimensional Terahertz Wave Imaging

KEY TECHNOLOGY AREA: Sensors (DTA-16)

OBJECTIVE: Demonstrate a real-time, two-dimensional, terahertz wave imaging system with a resolution exceeding 100x100 pixels at video frame rates.

DESCRIPTION: The terahertz (THz) region of the electromagnetic spectrum, spanning the wavelength range from approximately 1 mm to 100 m, has been greatly underutilized because of the difficulty in generating and detecting THz radiation. Remarkable progress has been recently made in the use of electronic and optical rectification to generate broadband coherent sources of THz radiation and the use of free-space, electrooptic sampling techniques for sensitive detection of the radiation [1, 2]. These advances offer the potential for real-time, two-dimensional, terahertz wave imaging, which would provide numerous new capabilities. Examples of applications include detection of pollutants; quality control in food products; diagnosis of diseased tissue; security screening for plastic explosives; short-distance, covert imaging; and collision avoidance for aircraft and ground vehicles. To realize this promise, the radiators need to be optimized for efficiency, power, radiation pattern and bandwidth, the detectors need to be optimized for sensitivity, speed, and resolution, and the components need to be optimally integrated into an imaging system.

PHASE I: Proof-of-principle analysis, including theoretical modeling to select optimal components such as the THz emitter, the electrooptic crystal, the CCD, and optical design.

PHASE II: Demonstration of system components and implementation of a prototype that allows two-dimensional imaging of THz waves with a spatial resolution of better than 100x100 pixels at video frame rates. Identify and resolve any key problems that might otherwise impede successful commercialization.

PHASE III DUAL USE APPLICATIONS: Real-time, two-dimensional THz wave imaging has an enormous potential commercial market in medical applications, environmental monitoring and security screening for difficult to detect plastic explosives, in addition to other commercial possibilities. Military applications include short-range, covert collision avoidance systems for helicopters, detection of chemical and biological agents, and testing of chemical battlefield uniforms.

REFERENCES:
1. A. Nahata, A. S. Weling, and T. Heinz, “A Wideband Coherent Terahertz Spectroscopy System Using Optical Rectification and Electro-optic Sampling”, Appl. Phys. Lett. **69**, 2321 (1996).
2. Z. G. Lu, P. Campbell and X.-C. Zhang, “Free-space Electro-optic Sampling with a High-Repetition-Rate Regenerative Amplified Laser”, Appl. Phys. Lett. **71**, 593 (1997).
3. D.M. Mittleman, R. H. Jacobsen, and M. C. Nuss, "T-Ray Imaging", IEEE J. of Selected Topics in Quantum Electron. **2**, 679 (1996).

ARMY98-T003 TITLE: Catalysis of Technologically and Environmentally Significant Processes

KEY TECHNOLOGY AREA: Chemical and Biological Defense (DTA 5)

OBJECTIVE: To prepare and optimize Polyoxometalate (POM)-containing or POM-based polymeric materials amenable to textile manufacture and other applications and capable of catalytic decontamination of chemical warfare agents. Recent research in the laboratory of Craig Hill at Emory University has revealed that POMs have promising utility in catalysis of several hydrolytic and oxidative processses, including for example the replacement of chlorine bleach in wood-pulp bleaching processes. Research in the destruction of chemical warfare simulants has been especially promising and new efforts in the preparation of thread and network POM-containing materials suggests that this research is ripe for capture and transfer into technology development.

PHASE I: Identify military and civilian processes where POMs could have significant impact and conduct proof-of-principle experiments to show that use of POMs will show an improvement over current technologies.

PHASE II: Expand the Phase I efforts to demonstrate scale-up potential and resolve any key problems which could otherwise prevent successful commercialization. Tests with live chemical warfare agents are required in Phase II if decontamination processes are a goal of the Phase I effort.

PHASE III DUAL USE APPLICATIONS: Protective clothing for the Agrochemicals industry such as pesticide and herbicide workers; self-decontamination fabrics and self-bleaching textiles. Removal of noxious sulfide odors from wood-pulp bleaching operations and other industrial processes. Applications of POMs in photocatalytic processes, e.g. water purification, are also expected.

ARMY98-T004 TITLE: Distributed Interactive Agents

KEY TECHNOLOGY AREA: Modeling and Simulation (DTA-19)

OBJECTIVE: Develop and demonstrate approaches to incorporating cognitive, emotional, personality, and moral components of human performance in modern simulations and models.

DESCRIPTION: Human behavioral characteristics are critically important to determining the outcome of land combat but there are few ways of inserting them into modern simulations and models. In particular, current army doctrine depends upon cognitive, motivational, and moral variables such as leadership, level of training, unit morale and cohesion. Distributed interactive simulations using the High Level Architecture (HLA) and virtual training technologies have matured steadily for use in training diverse skills at dispersed or remote locations, or for refreshing previously learned skills or knowledge. Yet, these technologies still do not include the impact of human behavior in warfighting analyses or simulations. Current models of constructive simulations use attrition-based algorithms and do not include important variables such as information flow management, fear, training proficiency, artillery suppression, and fatigue. These are difficult issues to capture in computational models and require new avenues of research in this fundamentally important area for the Army, to correlate and leverage diverse efforts. Significant progress might be possible if research efforts took advantage of the advances in modeling human agents and human performance in distributed communications of intelligent agents within financial, economic, industrial, and entertainment industries; using architectures arising from artificial intelligence and virtual reality research, such as production rules, neural networks, and semantic network systems. The potential gain from even small improvements in our understanding and ability to model human behavioral factors would be significant.

PHASE I: Demonstrate proof-of-principle of these approaches to modeling the human cognitive, emotional, personality, and moral components of human performance.

PHASE II: Application of the developed simulation and modeling technologies to an important training requirement.

PHASE III DUAL USE APPLICATIONS: Civilian applications could include industrial training, financial management, and entertainment businesses in addition to the large number of potential applications in the military combat modeling market.

NAVY STTR
PROPOSAL SUBMISSION

INTRODUCTION:

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. John Williams ((703) 696-0342). All SBIR Phase I and Phase II proposals as well as Phase III progress should be forwarded to Mr. Williams at the address below. If you have any questions, problems following the submission directions, or inquiries of a general nature, contact me. All Phase I proposals are due by 2:00 p.m. EST on **15 April 1998** and must be submitted to:

Office of Naval Research
ATTN: Mr. John Williams; ONR 362 SBIR
800 North Quincy Street
Arlington, VA 22217-5660
(703) 696-8528

NEW THIS YEAR:

1. The Navy is now requiring that all Phase I proposals have an electronically submitted Appendix A, B & E.
2. All Phase I award winners must electronically submit a Phase I Summary Report to the Navy at the end of the Phase I effort. This requirement will also be included in Phase II contracts and is described in further detail below.
3. The Navy requires that all Phase II proposals include an electronically submitted Appendices A, B and E.
4. The Navys Phase I base effort should run for 6 months (not 12 months as explained in the DOD section) and the Phase I option should run for 3 months.

PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria must be met or your proposal will be REJECTED.

1. **You must use the electronic format described in the section "Electronic Submission" described below. The Navy will not accept any proposals that are not submitted in electronic format for Appendices A, B, and E.**

2. **Your Phase I proposed cost for the base effort can not exceed $70,000 and should not exceed 6 months. Your Phase I Option proposed cost can not exceed $30,000 and should not exceed 3 months. The costs for the base and option should be clearly separate and identified on Appendix A, the cost proposal and in the work plan section of the proposal.**

3. **Your proposal must be received on or before the deadline date. The Navy will not accept late proposals, if you have any questions or problems with submission of your proposal allow yourself time to contact the Navy and get an answer to your question. Do not wait until the last minute.**

ELECTRONIC SUBMISSION OF APPENDICES:

There are two ways to submit your SBIR proposal to the Navy, the preferred method is the online submission. **The Navy <u>WILL NOT</u> accept the Red Forms in the rear of this book as valid proposal submission forms of the Appendix A, B and E or the Electronic download forms from any DOD Homepage.** Instead proposers must use **one** of the following procedures (**but not both**). The preferred and easier method is the Online Submission.

1. <u>Online Submission (through the Navy SBIR/STTR Bulletin Board)</u>

A. Go to SBIR/STTR Bulletin Board (http://www.onr.navy.mil/sci_tech/industrial/sbir_bbs), click on "Online/Electronic Data Entry Forms (SBIR/STTR)" then click on "Online Proposal Submission Interface".
B. Submit your Appendix A, B and E via the Online Submission option. Just fill out all the information requested, the screen format will look different then the forms in the solicitation. Once, you have filled in the data, follow the instructions to electronically submit appendices. That is, make sure you <u>click on the Submit button</u>.
C. After you have received acknowledgment of receipt, print out and sign the Appendix A/B and E form.
D. Submit the signed Appendix A/B and E form along with one original and four copies of your entire proposal (each copy should include a copy of the signed Appendix A, B and E forms) to the Navy STTR Program Office at the above address. Mark the outside of the envelope with your topic number.

2. <u>Diskette submission</u>

A. Obtain the Navy STTR Appendix A, B and E program from the Navy SBIR/STTR Bulletin Board (http://www.onr.navy.mil/sci_tech/industrial/sbir_bbs)
B. Select "Online/Electronic Data Entry Forms (SBIR/STTR)" and follow the instructions for Diskette Submission. For Mac users go to the forms for Macs.
C. **Don't select the highlighted sbir_ab.exe file, go down to the files specifically for STTR's.**
D. Data enter information.
E. Save file with .dat extension.(Do not save in a word processing format)
F. Print out and sign the Appendix A, B, and E form.
G. Submit the signed Appendix A, B and E form along with one original and four copies of your entire proposal (including 4 copies of the signed Appendix A, B & E form) together with a disk containing the .dat file generated from the Appendix A, B and E program to the Navy SBIR Program Office at the above address. (Please note we do not want the entire proposal text on disk, just the Appendix A, B and E.) Mark the outside of the envelope with your topic number.

NEW AT COMPLETION OF PHASE I AND PHASE II
ELECTRONIC SUBMISSION OF PROJECT REPORTS:

The submission of an Electronic Phase I Summary Report will now be required at the end of Phase I and a Phase II summary report at the end of the first and second year of a Phase II effort. The Phase I Summary Report is a summary of Phase I results, includes potential applications and benefits, and should not exceed 750 words. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR Bulletin Board at: "http://www.onr.navy.mil/sci_tech/industrial/sbir_bbs/" much like the Online submission of Appendices. If your company does not have access to the Internet consult your local library or local computer service store.

The Navy is initiating this new program to help increase the awareness and implementation of STTR funded efforts. The goal is to increase the market potential and transition of STTR projects by increasing the visibility and ease in accessing information about STTR projects to DOD, government and DOD industry contacts. This should facilitate the transition of these projects into follow-on efforts and bring additional revenue to the STTR Company.

To do this the Navy is requiring companies to provide information on the status and benefits of their technology developments so that this information can be put into a media that others can easily access and review (Like the Navy SBIR/STTR Database). The Navy plans to redistribute this information to a wide audience using such tools as the Navy Webpage, Accomplishment Book and a new interactive Navy STTR Website. This will help proved parties with technical challenges or those with the need to implement new technology, with a user-friendly mechanism to access and identify STTR companies that can provide them with solutions. This information should be **non-proprietary** yet detailed enough to provide the interested transition partner with enough knowledge to understand the potential use and benefit to their program.

YOUR SUBMISSION TO THE NAVY STTR PROGRAM:

This solicitation contains a mix of topics. When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Be sure that you clearly identify the topic your proposal is addressing. Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award (with the exception of Fast Track Phase II proposals – see section 4.5). If you have been invited to submit a Phase II proposal to the Navy by the TPOC, obtain a copy of the Phase II instructions from the Navy SBIR/STTR Bulletin Board on the Internet or request the instructions from the Navy STTR Program Office. All Phase I and Phase II proposals should be sent to the Navy STTR Program Office (at the above address) for proper processing. Phase III efforts should also be reported to the SBIR program office noted above.

The Navy will provide potential awardees the opportunity to reduce the gap between Phases I and II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. **The Navy will not accept Phase I proposals in excess of $70,000 (exclusive of the Phase I option).** The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I Option should be the initiation of the next phase of the STTR project (i.e. initial part of Phase II). When you submit a Phase II proposal it should consist of three elements: 1) a $400,000 maximum demonstration phase of the STTR project (i.e. Phase II); 2) a transition or marketing plan (formally called a "commercialization plan") describing how, to whom and at what stage you will market your technology to the government and private sector; 3) a Phase II Option ($100,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan for further R&D if the transition plan is evaluated as being successful. You must also submit your Phase II appendix A,B&E electronically to the Navy STTR Program Office at the address above. While Phase I proposals with the option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II Option will be limited to 40 pages (unless otherwise directed by the TPOC or contract). The transition plan should be in a separate document.

The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

The names of firms whose proposals have been selected for further consideration will be posted by topic number on the **Navy SBIR/STTR Bulletin Board**, under the STTR Program Information within 3 months of the proposal deadline. In addition the abstracts of companies that have received Phase I awards will be posted on the bulletin board within 5 months of proposal deadline.

Phase I awardees should submit a 5-page preliminary plan for Phase II to the Navy STTR Program Manager at the address above, 5 months and 2 weeks after contract award. However, only those Phase I awardees which have been invited to submit a formal Phase II proposal by the TPOC will be eligible for a Phase II award (with the exception of Fast Track Phase II proposals – see section 4.5). If you have been invited to submit a Phase II proposal to the Navy TPOC, get a copy of the Phase II proposal preparation and submittal guidelines from the Navy SBIR/STTR Bulletin Board.

NAVY FASTTRACK DATES AND REQUIREMENTS:

All Fast Track Applications and required information must be sent to the Navy STTR Program Manager at the address listed above and to the Contracting Officers Technical Monitor (the Technical Point of Contact (TPOC) for the contract). The following dates and information are required by the company to qualify for the FastTrack program. All of the requirements listed in the FastTrack Section of the front of this solicitation must be met. The information provided below provides specific dates and some additional information that is required by the Navy STTR Program Office.

Party/Days After Phase I Award **Required Deliverables**

STTR Company / 150 Days	- Fast Track Application and all supporting information. (See instructions in the DOD section of this Solicitation) - Phase II 5 Page Summary Proposal as is required of all Phase I projects described in Navy STTR Website, listed above) - It is strongly recommended that if you are contemplating the submittal of a Fast Track Application, you make your intention known to your technical point of contact (TPOC) and the STTR Program Manager - Request to initiate Phase I option (interim funding) which must have been included in original Phase I proposal.
STTR Company /181 - 200 Days	- Phase II Proposal - Phase I Final Report
Navy / 181 - 200 Days	- Navy will initiate option funding if all requirements are met.
Navy/ 201 - -205 Days	- Navy will formally Accept or Reject your Phase II proposal.
STTR Company /45 Days after Acceptance	- Proof that Funding has been received by STTR company.

N98-T001 TITLE: Multiscale and Multiresolution Image Enhancement and Classification System For Precision Strike

OBJECTIVE: Produce an integrated collection of computational tools, for PC's, which combine multiscale partial differential equations (PDE) and wavelet (multiresolution) image enhancement techniques with one or more methodologies for object (target) characterization. Demonstrate, on exogenous data, the effectiveness of enhancement for characterization/classification.

DESCRIPTION: Wavelets are a fairly well established technology for image processing and some good software is available [Ref. 1,2]. Successful applications include wavelet denoising, the use of wavelets to characterize texture and to search on this description, and image compression. Multiscale (PDE) methods [Ref. 3,4] are newer (late 80's to early 90's) and although little commercial software is yet available, many important applications have been demonstrated by universities. These include denoising/ deblurring, segmentation, optimal contrast enhancement, the use of color, and several others. A great deal of multiscale software is available from universities or could be easily constructed from published algorithms. The wavelet dictionary approach [Ref. 5] to object characterization, combined with sophisticated statistical pattern recognition [Ref. 6] shows great promise for classification/identification, but has not yet been applied to images.

The Navy is making increasing use of imaging sensors--SAR, ISAR, EO, IR, Optical for surveillance, precision strike, automatic target recognition, etc. All images contain a great deal of information which the unaided human viewer cannot see. The methods proposed here will make much of that information available and will aid target classification.

The aim here is to implement a selected subset of multiscale and multiresolution methods into a commercial quality software package with interfaces so that users can integrate other software. The criterion for selection of the methods to be implemented is to be their potential usefulness for enhancing not only images but classification on these images. This will, of course, depend on the classification method chosen for integrated implementation. The straw-man classification method is the use of wavelet dictionaries combined with statistical pattern recognition. Other methods may be proposed, but must be compared to and shown in some ways more promising than the straw-man. The contractor will demonstrate the system on a classification problem using data chosen by ONR and not used in the development of the classifier.

The product developed here is an advanced research and development software design tool in which image enhancement methods can be compared and evaluated in many ways, particularly with regard to their effect on classification.

PHASE I: Software candidates will be tested and "winners" chosen. Initial study of compatibility of enhancements methods with chosen classification methodology.

PHASE II: Integrated software system including multiscale and multiresolution methods and a classifier will be constructed and tested. Demonstration of classification will be carried out.

PHASE III: Develop and carry out commercialization plan for the software and the Navy will transition and implement this software into existing and future automatic target recognition and classification systems.

COMMERCIAL APPLICATIONS: The technology developed will have direct application in commercial space observation systems, in security/surveillance systems, and in forensics sciences.

REFERENCES:
[1] E. Hernandez and G. Weiss, "A First Course on Wavelets", CRC Press, 1996.
[2] A. Bruce and H-Y Gao, "Applied Wavelet Analysis with S-Plus", Springer, 1996.
[3] L. Rudin and S. Bramble, Editors, "Investigative and Trial Image Processing", SPIE Volume 2567, July, 1995.
[4] J.A. Sethian, "Level Set Methods", Cambridge University Press, 1996.
[5] N. Saito and R. Coifman, "Improved Local Discriminant Bases Using Empirical Probability Estimation", American Statistical Assn. Proceedings on Statistical Computing, 1996.
[6] Q. Huynh, L. Cooper, N. Intrator, and H. Shouval, "Classification of Underwater Mammals Using Feature Extraction Based on Time-Frequency Analysis and BCM Theory, IEEE-SP, Special Issue on Neural Net Applications, Nov. 1997.

N98-T002 TITLE: Hypersonic Weapon Sensors & Windows

OBJECTIVE: Develop highly accurate search sensors and windows with capabilities to perform in plasma flow fields at velocities of Mach 7.0

DESCRIPTION: At velocities approaching Mach 7, traditional search sensors (LWIR, RF, Optical, and Electronic) become limited in usefulness or ability to discriminate objects in or under the vehicle's flight path due to high energy states in the surrounding plasma flow field, or due to the need to heavily protect sensors from intense heat produced by aerofriction and heat radiation caused by the surrounding plasma. Development of a new type of sensor, sensor window, and set of robust filter algorithms which reduce plasma effects or operate regardless of the hypervelocity induced plasma environment surrounding a flight vehicle, and have a long sensing range (>10km) and image resolution suitable to perform sensing/search operations in time critical environments (<0.1 sec refresh rates) are necessary to overcome this limitation. Studies examining Sapphire (Aluminum Nitride) for midwave infrared seeker windows on high speed missiles have been shown to have strong thermal shock resistance, but at the cost of birefringence. Birefringence causes significant optical scatter and reduces the ability to produce an acceptable transparent polycrystalline seeker window. Materials with high thermal shock resistance, such as Sapphire, are also needed for the acceleration phase of an ascending hypersonic vehicle. The goal of this effort is to examine the effects of hypersonic flight on sensor and seeker window requirements. For Sapphire window and midwave IR seekers this could include the fabrication of a midwave IR (3-5 micron wavelength) window (aluminum nitride or other suitable window material) with a scatter of less than 2%, and an absorption coefficient less than 0.1 per centimeter, and thermal conductivity of 160 watts per meter Kelvin (at 20^{o}C), with a matched midwave IR search sensor. The effort would also study the effects of Mach 7 aeroheating and neighboring plasma fields on sensors performance in both flat and dome windows in both high and low altitude flight.

PHASE I: Identify window and sensor technologies to be developed and detail where and why they will be effective for hypersonic IR seeker applications. Identify sensor filtering algorithm requirements for onboard image processing systems. Determine ability to fabricate a seeker window by producing laboratory test samples and conducting suitable testing for transmittance and birefringence to show future ability to meet goals stated. Correlate sensor and window properties to projected hypersonic plasma fields, thermal shock loading, and aeroloading on typical flight vehicle structures.

PHASE II: Demonstrate the feasibility of fabricating sensor windows of a size well matched to suitably test and prove manufacturability by producing bench level test units. Address expected mechanical strengths and ability to survive thermal shock and temperature dwells from 20-1000^{o}C. Develop plans for processing hardware specifications, software toolkits, and sensor specifications (as required) to provide ability to search both in high altitudes (+17Km) and low altitudes (on near vertical decent). Provide test data from benchtop test and demonstrations to provide extrapolation for search performance characteristics in a plasma field. Develop commercialization (phase III) plan. Establish criteria for database of physical and optical qualities of seeker and window materials considered and investigated, including thermal conductivity, mechanical strength, modulus, expansion coefficient and optical absorption coefficient and populate with known or test data. Determine need for anti-reflection coatings and ability to survive long term sea state (Salt Fog/Sand Erosion) environment.

PHASE III: Implement phase III fabrication plan developed in Phase II.

COMMERCIAL POTENTIAL: This technology can be used for sensors and windows used in the process monitoring of high temperature processes including high thermal shock loading. The sensors and windows can also be used in commercial high high speed research, and spacelift platforms which require the ability to sense and detect inflight obstacles or are used for high speed environmental data gathering.

REFERENCES: D.C. Harris, :Infrared Window and Dome Materials," (ISBN 0-8194-0998-7) SPIE Press, Volume TT10, 1992

N98-T003 TITLE: Adaptable Sensor Processing and Data Fusion for Passive Target Identification and Recognition for Autonomous Systems

OBJECTIVE: Develop a reconfigurable, modular, adaptable signal processor to support multiple sensors and multiple platforms and develop imaging, fusion, and ATR methods for autonomous systems using passive sensors

DESCRIPTION: It is desired to develop a multipurpose signal processor and data fusion techniques for use in UAVs, weapon systems, and information-gathering systems to aid automated passive surveillance, target detection, classification, and identification, and scene generation. The goal is to develop multipurpose signal processor architecture to supports both multiple use and dynamic reconfiguration and to effectively fuse passive sensory data to form the tactical scene with sufficient resolution, to operate on available multisensor fused-database, to identify single objects (mobile or fixed), and to estimate target class, membership within a class, etc. in real-time. That is, the signal processor should be able to support systems equipped with different sensors as well as switching dynamically between different sensors during a mission. It should also be extensible, to support both low-cost single-sensor systems (by using one processor unit) or multi-sensor, high performance surveillance systems (by using multiple processor units).

The sensors that the processor should be able to support include staring infrared, conventional and low-light visible imagery, radar, millimeter-wave radiometry, electronic intelligence and anti-radiation homing receivers, Global Positioning System signal (including anti-jam processing and location of jammers) and support for data link transmission and reception. Sensor functions to be supported include feature extraction, automatic target recognition and region of interest identification, wavelet transforms, data compression, synthetic aperture. The processor should be dynamically reconfigurable such that it can support time-slicing of multiple operations, as well as changing modes stepwise through the mission or reconfiguration for different missions. Very high component density is needed for the small platforms, also desired are low-voltage and low-power circuitry, and dense packing assembly methods are important.

Passive all weather scene generation is a significant technical challenge, and high speed information signal processing , filtering and precise algorithms do not exist. Techniques used today for identification proposes range from well-known, statistical based algorithms such as classical inference and Bayesian methods to ad-hoc techniques such as template matching and adaptive neural networks. Passive surveillance techniques based on passive sensory information using integrated sensors such as Low-Light-Level-Charged-Coupled-Devices, IR, and Passive-millimeter-wave imaging devices are desired. The desired automated passive surveillance systems for autonomous systems are:

1. Registration and fusion of passive sensors (this issue is compounded by the fact that these sensors have different resolution and orientations);
2 Automatic target detection, cueing, and identification based on passive sensors;
3. Recognition algorithms based on;
4. Parametric classification using both the statistical (Bayesian, etc.) and information theoretic techniques (cluster algorithms, adaptive neural nets, etc.) pattern recognition and neural networks;
5. Cognitive-based models (Fuzzy Set Theory and Knowledge-based Systems);
6. Physical modeling (syntactic, estimation, or simulation)

The expected surveillance imagery and target information will be an accurate and concise estimate of the scene, target location and motion, target classification and attributes, and pertinent features.

PHASE I: Assess the functions and throughput required for the different signal processing tasks. Develop a set of hardware blocks that can be configured into an architecture to provide the needed functionality. Demonstrate key elements of the functionality in a simulation. Determine the approach for the fusion of advanced visible, infrared, and passive millimeter-wave imaging devices. Determine the scientific, technical merit, and feasibility of the application of the methods for Passive Automatic Target Identification and Recognition based on passive sensors on board a UAV. Quantify ATR performance

PHASE II: Demonstrate the complete architecture in a simulation. Fabricate prototype hardware and verify its performance, dynamic reconfigurability, and adaptability. Demonstrate the selected approaches and image fusion algorithms in real-time using multipurpose signal processor environment in an autonomous fashion.

PHASE III: Produce signal processors for use in new weapon systems. Potential applications include targeting sensors and a terminal seeker for Guided Munition. Develop and carry out commercialization and transition plan

COMMERCIAL POTENTIAL: Adaptable Sensor Signal Processors and Passive Target Identification and Recognition have direct applications to video image processing, image compression, multi-spectral imagery for land-use planning, forestry, and agriculture, high-performance data communications, image recognition in factory, security., and intelligent highway systems.

REFERENCES:

K. Fukunaga, “Statistical Pattern Recognition”, Academic Press Inc., 1991, New York NY., Proc IEEE, January 1997, “Special Issue on Data Fusion”

N98-T004 TITLE: Laser Initiation Of Explosives

OBJECTIVE: Development of a analytical method for determining initiation and transition to detonation of typical secondary bulk HMX, TNT and RDX wax based and plastic bonded explosives (such as Octol, PBXN-110 or Comp-C4) with or without a thin cover of aluminum or steel, due to localized laser excitation. The method used must be translatable to developments using standard explosive modeling to examine localized effects of heating, excitation and component material degradation.

DESCRIPTION: There is a need to improve the ability to model high energy laser technology and plastic bonded high explosive interaction for laser based ship defense, explosive operations safety, and demilitarization operations. Laser initiation of explosive molecules and individual constituent components (such as plasticizers and binders) have been investigated previously, however the examination of laser induced thermal decomposition and simultaneous shock initiation of commonly used plastics explosives with HMX, RDX and TNT bases with and without covers of aluminum or steel have not been thoroughly investigated. Initiation theories of damaged materials and their interactions with thermal shocks, physical shocks or high energy plasma states produced by the laser, or on a covering metal plate, are not well developed for un-dope-ed explosives, such as Octol or Composition C-4. Statistical as well as probabilistic approaches may be required to determine reaction severity, such as deflagration and detonation. Basic theoretical developments are required to improve predictive and analytical capabilities for laser induced detonation of common un-doped explosives, inside and outside metallic containers or warheads.

PHASE I: Development of theoretical techniques and analytical or statistical models for implementation of Laser initiation of common plastic bonded and common wax based cast explosives (such as Octol). Determine ability and energy requirements for common or commercially available laser systems, such as FEL and Q-switched lasers to successfully detonate undoped explosives. Development of small scale laboratory experiments suitable for examining explosive reactions and influence of both laser strength and duration. Determine atmospheric and weather impact on various laser systems output and determine output energy and time on target requirements for distances from 5 meters to 20 kilometers.

PHASE II: Conduct small scale, and if needed, large scale explosive testing to validate, populate, or construct numerical, statistical, and/or probabilistic models for laser initiation of common explosives with and without metallic casing materials. Develop a demonstration system capable of detonating visible, but small anti-personnel mine systems or submunitions, such as unfuzed M42 or XM-80 antipersonnel grenades. Develop fabrication and system requirements for both small and large scale laser systems capable of detonating cased and uncased explosive materials in the field or for shipboard use. Develop commercial technology transfer and commercialization plans, including descriptions of additional and specific tests, evaluations, and implementations to be performed.

PHASE III: Develop a road map for making these capabilities operational and ready for transition. Demonstrate predicted performance in operational or industrial setting. Upon testing and evaluation, the system will be commercialized.

COMMERCIAL POTENTIAL: The technology developed here can be used to increase the safety and sequential accuracy of multiple charge detonation used in mining and building demolition applications, and eliminate the need to transport larger demolition explosives over rail and road. The technology can also be applied for humanitarian operations such as demolition of dud munitions in the field.

N98-T005 TITLE: Learning and Adaptation for High-level Intelligent Control in Rapidly Varying Environments

OBJECTIVE: To investigate the methodology of Multiple Models, Switching and Tuning for Nonlinear Systems, and its applications to flight control of Air Vehicles.

DESCRIPTION: Control system design has traditionally been based on a model of the system to be controlled. The best developed part of control theory deals with the control of linear time-invariant systems. If the system is assumed to be linear and time-invariant and is described by equations that are known, powerful methods exist for its control. Adaptive control that was developed in the 1970s and 1980s deals with the control of linear systems whose parameters are either constant or vary slowly with time. However, as systems become more complex, a new class of problems is being encountered for which general methods of control have to be developed. This class of problems is characterized by rapidly changing environments, failures in sensors and actuators, navigation with new structural information, control in the presence of changing performance criteria or reference trajectories are typical examples of such problems. The task of the control system in the above cases is to recognize the situation that exists and provide the appropriate control input in a relatively short time. Conventional robust and adaptive control methods are not adequate to achieve this objective, and more sophisticated methods are needed.

A new methodology has been developed recently based on multiple models, switching and tuning [Ref. 1]. The basic idea of the approach is to store models of the different environments in which the plant may be expected to act, determine which environments currently exists, and use the appropriate controller. Extensive theoretical analysis, stability proofs, and computer simulations have been carried out. On the basis of the work done thus far it has become clear that the general approach has enormous potential both as a source of interesting theoretical problems and as a methodology of great practical relevance.

The overall objective of the project is to investigate the methodology of multiple models, switching and tuning in the context of nonlinear models of air vehicle dynamics. Using artificial neural networks, numerous complex nonlinear systems can be controlled [Ref. 2]. Some of the questions to be addressed are as follows:

1. How are different models of the system to be created? Is the generation of the models specific, or can general procedures be developed? What are the conditions that the system must satisfy if models are to be generated successfully?

2. Should the models be fixed or adaptive or should a combination of the two be used?

3. If new models are to be created, should old models be discarded? If so, on what basis should this be carried out?

3. What is the criterion that determines the choice of a controller at any instant?

4. Is learning to be an ongoing process or to be initiated at the discretion of the designer?

5. What is the criterion used for the creation of a new model?

The above questions relate to the application of the new methodology to model reference control. The scope of the problem should also be extended to include general optimal control problems. To obtain on-line solutions to such problems, substantial amounts of information must be gathered off-line and stored in neural networks.

Air vehicles, due to their complexity and high nonlinearity provide an ideal benchmark for the methodology. The project will investigate the applicability of Multiple Models, Switching and Tuning for the control of such vehicles in nonlinear uncertain regimes such as high angles-of-attack.

PHASE I: Investigate the problems associated with the utilization of the methodology of "Multiple Models, Switching and Tuning" for nonlinear systems using neural networks. Investigate the applicability of these methods for the control of air vehicles operating in nonlinear and time varying flying regimes, and subjected to failures and inherent uncertainties.

PHASE II: Develop a prototype of a "Neurocontroller" for a specific air vehicle, capable of performing autonomously during the course of an entire flight procedure. Demonstrate its performance characteristics. Develop a commercialization plan, including descriptions of specific tests, evaluations and implementations to be performed.

PHASE III: Carry out the commercialization plan developed in Phase II.

COMMERCIAL POTENTIAL: The resulting system will have broad applications in power industry, manufacturing, commercial aviation systems, and other areas.

REFERENCES:
[1] K. S. Narendra and J. Balakrishnan, "Adaptive Control using Multiple Models", IEEE Transactions on Automatic Control, Vol. 42, No. 2, pp. 171-187, February 1997.

[2] K. S. Narendra and Sai-Ming Li, "Neural Networks in Control Systems", a chapter in "Mathematical Perspectives on Neural Networks", P. Smolensky, M.C. Mozer, and D.E. Rumelhart.

N98-T006 TITLE: Intelligent Supervisory Control Architecture for Health Monitoring, Fault-detection, Sensor Management, and Reinforcement Learning System for Adaptive Air Vehicles

OBJECTIVE: Develop flexible architectures, software tools, and systematic procedures for the design of intelligent adaptive air vehicles capable of:

1. Real-time supervisory systems control;
2. Health monitoring and fault detection for vehicles operating in multiple regimes Real-time dynamic performance and model validation;
3. Real-time reconfiguration and resource management should an unanticipated event occur;
4. Real-time reinforcement learning for adaptive control and allocation of sensors.

DESCRIPTION: Future air vehicles will be expected to operate in a wide range of flight regimes, under stringent flight commands and mission constraints, and in the presence of large uncertainties and subsystem failures. Hence, there is a need for developing a truly intelligent supervisory systems control architecture capable of achieving the desired performances autonomously while operating in a time-varying environments, in the presence of large external and/or internal perturbations, and systems failures.

The proposed effort should focus in part on the development of intelligent adaptive control in the presence of parametric uncertainty for the identification and control of unknown nonlinear systems. [1-5].

Verifying performance and safety under all possible operating conditions for complex systems such as UAVs are very difficult because of unanticipated faults, or operational circumstances, or design omissions. It is critical to have an autonomous monitoring system that is capable of real-time diagnostics, fault detection, and resource management. The proposed effort should develop a real-time monitoring system and supervisor that would have real-time capabilities such as: fault detection and model validation; performance prediction; reconfiguration and resource management, and feedback design. It should have a hierarchical structure with continuous as well as discrete controllers. The lower layer of the supervisor would continuously collect the data from various subsystems and perform the task of model validation and fault detection. The higher level of the supervisor would be involved in making decisions regarding reconfiguration, development of new control strategies/laws, and resource management.

A health monitor/fault detector (HM/FD) for a system compares the states of the system with certain bounds known to be satisfied by a "healthy" system, and flags an alarm if these bounds are violated. More sophisticated algorithms are capable of classifying faults. One key assumption followed in the design of current HM/FD algorithms is the existence of one unique "healthy" operating regime, against which the running system is compared. Many practical systems however operate in different regimes. “Regime” means a region of state space, defined by bounds on certain state variables of interest, such as angle of attack, or speed. Dynamics of a system can change from one regime to the other, so if a system with an HM/FD algorithm designed to operate on just one regime, will flag as a fault when it switches to a different regime. The proposed effort should investigate HM/FD algorithms capable of operating on different regimes utilizing gated networks. The goal is to design HM/FD algorithms which work well on a certain regime. These local algorithms are labeled gated experts, and “adapt” their width to match the noise level in that regime.

Reinforcement Learning (RL) methods are novel combinations of dynamic programming (DP) methods, stochastic approximation methods, and learning methods [6-9]. Learning classifier systems (LCS) are ruled-based machine learning systems that use genetic algorithms (GAs) as their primary rule discovery mechanism. LCS methods allow global optimization and can be used to solve DP problems.

Sensor management involves the selection and adaptive allocation of sensors, sensor modes, and sensor parameters to maximize their collective effectiveness for mission requirements. Sensor management systems for tactical air vehicles have been constructed using a variety of ad hoc methods. Most often these systems employ rule-based approaches and rely on the operator to make many real-time deployment decisions. The proposed effort should formulate the problem of sensor resource control and allocation within a mathematical programming framework and use RL to develop an optimal sensor management system.

PHASE I: Conduct a feasibility study of the suggested intelligent supervisory systems control architecture, the development of a real-time monitor and supervisor capable of real-time fault detection, performance prediction, model validation, real-time reconfiguration, feedback design, resource management should an unanticipated event occur, and gated networks combined with gated experts for designing HM/FD algorithms for systems operating in multiple environments. Test the suggested concepts using several benchmark examples.

PHASE II: Develop a prototype of the intelligent architecture and autonomous HM/FD system capable of operating well during the entire course of a flying procedure; test the concepts on a practical system; demonstrate performance characteristics; utilize reinforcement learning systems to optimally manage and allocate sensor resources; demonstrate use of optimization algorithms for adaptive flight control; develop a commercialization/transition Phase III plan, including descriptions of specific tests, evaluations, and implementations to be performed.

PHASE III: Develop a road map for making these capabilities operational and ready for transition. Demonstrate real-time performance. Upon testing and evaluation, the system will be commercialized.

COMMERCIAL APPLICATIONS: The resulting system will have broad applications in power industry, manufacturing, commercial aviation systems, and other areas.

REFERENCES:

[1] K. S. Narendra and K. Parthasarathy, "Identification and Control of Dynamical Systems Using Neural Networks", IEEE Transactions on Neural Networks, Vol. 1, pp. 4-27, 1990.

[2] J. D. Boskovic, "A Multiple Model-Based Controller for Nonlinearly-Parametrized Plants", Proc. 1997 Automatic Control Conference, Albuquerque, New Mexico, June 1997.

[3] K. S. Narendra, R. Shorten, and J. D. Boskovic, "Intelligent Control Using Multiple Models", Proc. the Ninth Yale Workshop on Adaptive and Learning Systems, New Haven, July 1996.

[4] K. S. Narendra and J. Balakrishnan, "Adaptive Control using Multiple Models", IEEE Transactions on Automatic Control, Vol. 42, No. 2, pp. 171-187, Feb 1997.

[5] C. Garcia, D. Prett, and M. Morari, "Model Predictive Control: Theory and Practice - A Survey", Automatica, Vol. 25, No. 3, pp. 335-348, 1989.

[6] R. S. Sutton and A. Barto, “Reinforcement Learning: An Introduction", MIT Press 1998.

[7] L.P. Kaebling, M. L. Littman, and A. W. Moore, “Reinforcement Learning: A Survey", Journal of Artificial Intelligence Research, Volume 4, 1996, pp. 237-284.

[8] S.W. Wilson,"ZCS: A zeroth level classifier system "Evolutionary Computation, 2(1), 1994, pp. 1-18.

[9] S.W. Wilson, “Classifier fitness based on accuracy”, Evolutionary Computation, 3(1), 1995, pp. 149-176

AIR FORCE
PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force STTR Program is with the Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio. The Air Force STTR Program Executive is R. Jill Dickman, (800)222-0336. **DO NOT** submit STTR proposals to the AF STTR Program Executive under any circumstances. Addresses for proposal submission and numbers for administrative and contracting questions are listed on the following page

Technical questions may be requested using the DTIC SBIR Interactive Technical Information System (SITIS). For a full description of this system and other technical information assistance available from DTIC, please refer to section 1.5.c of this solicitation.

Pre-Solicitation Announcements (PSA), listing the full descriptions of the topics and the author of each, were issued by the individual AF laboratories in electronic and hard copies, after being announced in the Commerce Business Daily. Contact the laboratories directly for information on future PSAs (see activity/mailing addresses and phone numbers on the next page). Open discussions were held with the topic authors concerning technical aspects of the topics until this solicitation was released. Small businesses that did not know about the PSAs or did not participate in the exchange may find relevant questions or comments from these talks listed in SITIS.

For each Phase I proposal, send one original and three (3) copies to the office designated on the following page. Be advised that any overnight delivery may not reach the appropriate desk within one day.

Unless otherwise stated in the topic, Phase I will show the concept feasibility and Phase II will produce a prototype or at least show a proof-of-principle.

Air Force Fast Track

Detailed instructions on the Air Force Fast Track and Phase II proposals, consistent with this solicitation (section 4.5), will be given out by the awarding Air Force directorate along with the Phase I contracts.

PROPOSAL SUBMISSION INSTRUCTIONS

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
	(Name and number for mailing proposals and for administrative questions)	(For contract questions only)
AF98T001	CANCELLED	
AF98T002 thru AF98T010	Air Force Office of Scientific Research AFOSR/NI (Chris Hughes) 110 Duncan Avenue, Room 5115 Bolling AFB DC 20332-8050 (Chris Hughes, (202) 767-6962)	Ernest Zinser (202) 767-4992
AF98T011 thru AF98T013	Avionics Directorate WL/AAOP (Marleen Fannin) 2241 Avionics Circle, Bldg 620 Wright-Patterson AFB OH 45433-7318 (Marleen Fannin, (937) 255-5285, x4117)	Terry Rogers (937) 255-5830 Bruce Miller (937) 255-7143
AF98T014 thru AF98T017	Materials Directorate WL/MLIP (Sharon Starr) 2977 P Street, Suite 13, Bldg 653 Wright-Patterson AFB OH 45433-7746 (Sharon Starr, (937) 255-7175	Terry Rogers (937) 255-5830 Bruce Miller (937) 255-7143
AF98T018 thru AF98T020	Armament Directorate Wl/MNPM (Dick Bixby) 101 West Eglin Blvd, Suite 140 Eglin AFB FL 32542-6810 (Dick Bixby, (850) 882-1281)	Lorna Tedder (850) 882-4296, x3399

FY98 AIR FORCE STTR TOPICS

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, BOLLING AFB DC

AF98T001	CANCELLED
AF98T002	Advanced Adhesives for Aerospace Structures
AF98T003	Microsatellite and Nanosatellite Propulsion
AF98T004	Optical Fiber Phenomena, Processing, and Devices
AF98T005	Combat Simulation Analysis of Advance Technology Weapons Concepts
AF98T006	Sensor Fusion for Image Display
AF98T007	Polymers for Flexible Electronics and Photonics
AF98T008	Real Time Intelligent Coaching for Command and Control
AF98T009	Novel Mathematical / Computational Approaches to Surveillance Image Transmission and Exploitation
AF98T010	Upgrading of PIC Codes for HPM Tube Design

WRIGHT LABORATORY – AVIONICS DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF98T011	Innovative, Affordable Sensing for Aerospace Platforms
AF98T012	Automatic Target Recognition and Sensor Fusion Research
AF98T013	Military Essential Electron Device Development

WRIGHT LABORATORY – MATERIALS DIRECTORATE, WRIGHT-PATTERSON AFB OH

AF98T014	Simulation-Based Design System for Multi-Stage Manufacturing Processes
AF98T015	Carbon Nanotube Materials for Air and Space Applications
AF98T016	Evanescent Fields for High-Speed, Non-intrusive Materials Processing and Assessments
AF98T017	Polymeric-Based Materials and Polymer-Nanocomposites for Thermal Management and Electrical Signal Distribution of USAF Satellites and Aircraft

WRIGHT LABORATORY – ARMAMENT DIRECTORATE, EGLIN AFB FL

AF98T018	Weapon Flight Mechanics
AF98T019	Sensor Concepts for Autonomous Guidance
AF98T020	Ordnance Technologies for Advanced Munitions

FY1998 STTR Topic Description

AF98T002 TITLE: Advanced Adhesives for Aerospace Structures

OBJECTIVE: Develop high temperature adhesives and low shrinkage adhesives for bonding airframe joints and to search for new NDI methods for the evaluation of joints bonded by these adhesives.

DECRIPTION: It is recognized that adhesive bonded joints have superior weight saving characteristics compared to bolted joints. Current aircraft construction uses thousands of rivets which contribute to a substantial weight fraction of the total airframe weight. Structural weight is often a critical design issue in modern military aircraft and missiles because it will determine the operational envelope such as speed and range, and on-board capabilities such as weapon load and "smartness" of the aircraft. In stealth applications, adhesive bonded structures, as opposed to riveted structures, are critical in controlling radar cross section in many areas. Additionally, these stealth structures require high temperature adhesives which are becoming a limiting factor that prevents successful development of light weight stealth airframe and engine components. Composite patch repair of aging aircraft is supposedly a superior repair meted because it does not require significant additional weight and drilling additional holes that weaken the original structures.

In spite of all these advantages, adhesive joining method is not widely used today because of a serious lack of scientific understandings in this technology and in certain cases, a lack of appropriate materials. So adhesive bonding is only used as a vary last resort. This is underscored by the fact that fasteners are added to adhesive repaired parts today to provide added insurance in mechanical integrity, thus negating the advantage of adhesive bonded joints. The new holes drilled for the fasteners, in addition to weakening the structures by acting as stress concentrators, are creating many additional maintenance issues such as fuel leakage.

This lack of confidence is due to a lack of Nondestructive inspection (NDI) method to distinguish a good bond vs. a bad bond. Bondline degradation is a critical concern but the mechanism is poorly understood and there is no reliable method to detect a good bond turning bad and/or to predict the residual bondstrength of an aged bond.

(1) New adhesives:- High temperature adhesives to meet Air Force requirements, and zero-shrinkage adhesives for minimizing internal stress at the bond line. New high temperature adhesive is needed to match the new high temperature composite capability. This is critically needed in stealth structures. The adhesive needs to be compatible with the matrix of the high temperature composite, but also possesses the right rheological behavior and processing parameters to function as an adhesives. Aromatic or heterocyclic aromatic structures with proper thermosetting functional groups will be investigated. It is well known that adhesive shrinks during cure, thus subjecting the polymer in the bondline to be in a constantly high state of tri-axial stress. This is a severe factor in limiting the bond strength of adhesive bonded joints. The shrinkage issue is also of critical importance to opto-electronic packaging because shrinkage causes misalignment of micron size optical elements, a critical issue to be addressed in improving the yield of opto-electronic devices.

(2) Pre-damage Nondestructive Inspection (NDI):- All existing NDI methods detect voids and cracks. A substantial comulation of chemical damage would have occurred prior to crack initiation. The strength of the bonded structure would have been compromised before the current NDI methods can detect any changes. These techniques are also inadequate to distinguish a good bond vs. a bad bond, e.g. a bond that has good chemical bonding between the adhesive and the adhered (cohesive failure in bonding test) vs. a "kissing bond" (adhesive failure in bonding test). New NDI methods (e.. high frequency dielectric measurement in the Ghz range) that prove the integrity of the chemical bonding between the polymer and the adhered instead of macroscopic continuity is needed.

PHASE I: Propose candidate materials for use as bonding adhesives. Conceptually demonstrate the superiority of these materials of those currently in use. Propose NDI techniques that can detect physical and chemical degradation of the bonded joints.

PHASE II: Use proposed adhesives in bonded joints and demonstrate their superiority via new NDI technique to test and validate bond strength and integrity.

PHASE III DUAL USE APPLICATIONS: Develop viable adhesives and evaluation techniques for commercial application in many forms of lightweight structures. Commercial applications are potentially numerous. Strong, light weight joints with reliable inspection techniques will be useful in many transportation systems including automobiles, ships and commercial aircraft.

REFERENCES:

1. "Structural Adhesives", A Report for National Materials Advisory Board, National Research Council, R. L. Patrick, Ed., Marcel Dekker, New York, 1976.
2. "Structural Adhesives", S. R. Hartshorn, Ed., Plenum Press, NY, 1986.

AF98T003 TITLE: Microsatellite and Nanosatellite Propulsion

OBJECTIVE: Develop micro-thrusters based on sub-micron-scale and larger that could produce impulse bits less than 10-9 nanoseconds for precision thruster applications. These thrusters should exploit non-conventional physical processes that occur at the sub-micron scale.

DESCRIPTION: Microsatellites and nanosatellites (defined as those lighter than 100 kg and 1 kg respectively) are gaining interest in the DOD community. The recent successes in micro-devices, such as fingernail-sized cameras, are leading to microspacecraft weighting as little as 5 kg. High-density digital electronics in smaller and smaller units translates into smaller and smaller space vehicles. However, no single factor constrains the design of space vehicles and the execution of their mission more than the state of art in propulsion technology. Micro-chemical propulsion can be used as a primary thrust system for orbit insertion, trajectory-control, and attitude control. Micro-electric propulsion may achieve some high delta-V maneuvers and attitude controls. Micro-thrusters based on sub-micron-scale and larger structures could produce impulse bits of less than 10-9 nanoseconds for precision thruster applications and could exploit non-conventional physical processes that occur at the sub-micron scale. Batch operation enables the generation of higher thrust levels and impulse bits by parallel operation of many individual micro-thrusters. Batch-fabrication also enables inexpensive replication of entire thruster modules in lots of several hundred. The objectives are cluster-built pulsed solid/gas propulsion systems, micro-ion, micro-pulsed plasma thrusters, micro-resistojets, and other possible alternatives.

Scaling available thrusters to the required sizes presents several problems since most macroscopic physics do not apply at the non-continuum micron-level scales. For example, the breakdown voltage of micro-plasma is not known, nor is the gas flow behavior in micro-nozzles. Micro-nozzles suffer from boundary-layer effects which become more dominant as the local Reynolds number decreases. The Maxwell equations may not be valid at this scales. New electromagnetic theory for micro scales may be necessary. More fundamental studies needs to be done in characterizing combustion and plasma dynamics in microscopic scales for future revolutionary micro-thrusters.

PHASE I: Design and test feasibility of proposed micro-thrusters.

PHASE II: Develop and test prototype of micro-thruster.

PHASE III DUAL USE APPLICATIONS: Increasing use of microsatellites for numerous commercial applications has made the entire area a growth industry. Micro-propulsion devices would have a wide range of customers not only in the industries associated with satellite technology but in other space applications.

REFERENCES:
1. Mueller, Juergen, Overview of Micropropulsion Workshop, Jet Propulsion Laboratory, 7 April 1997.
2. Janson, S. W. and Hevajian, H., "Batch-Fabricated Microthrusters: Initial Results," AIAA-96-2988, 32nd AIAA/ASME/SAE/ASEE Joint Propulsion Conference, 1-3 July 1996.

AF98T004 TITLE: Optical Fiber Phenomena, Processing, and Devices

OBJECTIVE: Advance the applications of optical fibers in devices and systems of importance to the Air Force by studying phenomena, preparation and processing of fibers, and new fiber devices based on advanced processing techniques. Develop a better understanding of fiber materials phenomena and the interactions of fibers with optical radiation Develop new and better techniques for doping and controlling the doping profile of fibers, and new techniques for making special shape and special geometry multiple core fibers with controlled dopants.

DESCRIPTION: Optical fibers have emerging applications as lasers, distributed and point sensors, and signal processors, in addition to their better known applications in communications. In communication systems, fibers are finding increasing applications other than signals carrying such amplifiers, signal conditioners, filters, and multi- and demultiplexors. Most of the emerging applications of optical fibers depend on special properties of the fiber or its preparation. Examples include special doping and doping profiles, special shapes and configurations, such as multiple cores, and the ability to build in index of refraction variations (e.g. Hill gratings). This topic seeks to advance the important applications of optical fibers in devices and systems of importance to the Air Force by studying phenomena, preparation and processing of fibers, and new fiber devices based on advanced processing techniques. Of interest are better understanding of fiber materials phenomena and interactions of fibers with optical radiation, new and better techniques for doping and controlling the doping profile of fibers, and new techniques for making special shape and special geometry multiple core fibers with controlled dopants. Also of interest are better, more flexible techniques for writing gratings in fibers. Some of the techniques include, core and cladding; improved understanding of the physics and engineering of such fiber gratings, including direct writing of the gratings; the use of additional dopants and treatments, such as hydrogen loading in the fibers to increase the UV sensitivity and stability of fiber gratings; developing the ability to manufacture fiber gratings without having to strip and recoat the fiber; and control of the tensile strength of fiber gratings.

PHASE I: Propose and develop new concepts and identify the means for their implementation

PHASE II: Develop special fibers, demonstrate devices based on them, possibly with collaborators, and will supply prototype quantities of special fibers to others for device fabrication.

PHASE III DUAL USE APPLICATIONS: Apply improved fibers and better processing technologies to commercial applications in industry. Many customers are available for better technology in this area and fiber optics is a developing market. The telecommunications industry, medical industry, as well as the defense sector would all benefit by improved fiber optics materials and technology.

REFERENCES:
1. Photosensitivity and Quadratic Nonlinearity in Glass Waveguides: Fundamentals and Applications, volume 22, 1995 OSA Technical Digest Series, (Optical Society of America, Washington, DC 1995)
2. Fiber Optic and Laser Sensors Nine, R.P. DePaula & E. Udd, ed, SPIE, Bellingham, WA (1992)

AF98T005 TITLE: Combat Simulation Analysis of Advance Technology Weapons Concepts

OBJECTIVE: Innovative concepts are sought to harness the growing capabilities of combat modeling and simulation (M&S) software to meaningfully quantify actual warfighting impact of proposed technical improvements to operational defense systems. It is desired to so advance the state of the art as to permit head-to-head quantified combat benefit comparisons before expenditure decisions are made to actually modify existing systems or to manufacture new ones.

DESCRIPTION: Research in areas such as directed energy weapons, low observables, electronic countermeasures, and sensors is driven by the desire to enhance the warfighting effectiveness of our combat systems. Predicting the magnitude of that enhanced combat capability in quantitative terms remains a subjective art. It remains virtual guesswork to predict the relative warfighting benefits of one proposed technical advance compared to a competing one. The high cost of such advanced technology acquisition programs encourages the search for a more objective evaluation methodology. One promising alternative is combat simulation software which would permit the R&D acquisition decision maker to directly examine the simulated effect of the proposed innovation on modeled combat systems in realistic war scenarios. Such software could enable the user to adjust targeted performance characteristics to gauge which incremental technical improvements offer the highest combat-effectiveness payoffs. Limited defense dollars could then be targeted to the higher payoff technology. Artificial intelligence should directly assist the selection of realistic points in parameter-space, the proper insertion of the new technology in all relevant weapons systems, and likely possibilities for enemy countermeasures. The resultant computational capability would also serve warfighters in formulating strategy and tactics for optimum employment of new capabilities entering the inventory.

PHASE I: Propose and study new approaches in simulation algorithms for both realistically reflecting the physical capabilities of new electronics-based technologies as well as evaluating their real world effects. Identify, justify, and fully characterize an optimal combat simulation software package that will serve as the basis for the eventual M&S evaluation system. The choice should be governed by ensuring maximum coverage of Air Force systems, user-friendly interface for non-computational users, and ease with which the evaluation-specific algorithms can be inserted. Formulate the methodology for accurately incorporating the effects of weapons system technology enhancements in said tactical and/or operational combat simulation software. Provide examples of the specific quantitative output which the final software will yield to aid technology acquisition decisions.

PHASE II: Innovate a complete prototype combat simulation software package which will permit the interactive insertion and evaluation of advanced technology capabilities in realistic warfighting environments and which will yield quantitative combat effectiveness impact output data to guide technology acquisition decisions.

PHASE III DUAL USE APPLICATIONS: The resultant software could be accepted as a standard for advanced technology acquisition evaluations throughout the Department of Defense as well as defense contractors. Furthermore the advanced internal logic of such a software package could be transferred to other baseline M&S software to facilitate similar acquisition decision making over a wide range of fields such as transportation, communications, and computer systems.

REFERENCES:
1. "TACtical SIMulation (TACSIM) Users Manual," TACSIM Project Office, Manassas, VA, 1995.
2. "Joint Exercise Driver for Intelligence (JEDI) Terminal Operations and Sample Messages Guide," Doc JED-VED-9400, Joint Warfighting Center, Hurlburt Field, FL, 1994.
3. "Digitizing the Future," DMA No. DDIPDIGITALPAC, Defense Mapping Agency, Fairfax, VA, 1992.

AF98T006 TITLE: Sensor Fusion for Image Display

OBJECTIVE: Develop Multi-spectral image display technology for use in military systems. Multi-spectral is meant to include polarimetric images within a single spectral band or non-image data that may be fused with image streams.

DESCRIPTION: Human capability for processing the ever-increasing volumes of multi-spectral images is in short supply. For example, imagery sources are increasing in number without a corresponding increase in the number of human image interpreters. In fact, there is real concern regarding the decrease in both the number and experience level of military imagery analysts. For example, multi-spectral images are increasingly available, but no standard for human viewing of multi-spectral images has yet been developed. Both the military and the commercial sectors have made large investments in algorithms for the automated exploitation of multi-spectral imagery. Many of these algorithms employ non-intuitive computations, such as the ratio between pixel intensities in specific wavelength bands. The human interpreter is provided with no capability to verify the results of the automation. Such difficulties are expected to worsen as hyper- and ultra-spectral imaging systems continue to mature. This topic seeks proposals to discover new image processing technologies based on human and biological image processing. Human and other biological systems are known to process images in multiple spectral bands that are held in registration during target recognition and navigation. Further, many of the processing steps of human vision are known and have been formally described, often in terms of algorithms for image processing. This topic encourages the extension of algorithmic descriptions of human multi-spectral image processing to the domain of image display processing. The overall technology objective is a display of fused multi-spectral images with measurable advantages for human tasks of interpretation and navigation. Secondary technology objectives include real-time image processing, feature and target segmentation, and wearable, head-mounted, displays. Technology challenges include: (1) spatial registration of multi-spectral static and moving image streams, (2) dynamic range compression or normalization to prevent display saturation, (3) false coloring of fused images for improved human image segmentation and target recognition, (4) benchmark tasks to enable quantitative comparison of various solutions to problems of human image processing performance in recognition and navigation.

PHASE I: Construct algorithms for false color display of multi-spectral image data.

PHASE II: Do studies to determine image rendering best suited for tasks of recognition and navigation given state-of-the-art cockpit environment.

PHASE III DUAL USE APPLICATIONS: Improved technology for displays for multi-spectral images would benefit several domains where multi-spectral images are encountered, including: agriculture, for satellite image processing for crop identification and yield estimation; medicine, for medical imaging of combined MRI and X-ray data, for example; weather, for imaging of wind and temperature in combination, for example; and others.

AF98T007 TITLE: Polymers for Flexible Electronics and Photonics

OBJECTIVE: Develop the materials and processing methodology for developing flexible electronic, and photonic devices.

DESCRIPTION: Many advanced systems and smart structures will require low cost conformal and/or flexible electronic and/or photonic circuitry. Examples of these applications include conformal phase array antenna and receivers, ergonomical head-mounted displays for Air Force pilots, flexible displays, deformable smart wings or structures for aircraft, microsatellites and small size unmanned aerial vehicles (UAV). Polymers are well known for their low cost processing and their mechanical integrity. With the recent surge on functional properties research in polymers, they have been shown to possess interesting electronic and photonic properties. This class of materials is ideal for developing flexible electronic and photonic components, devices and even systems for the above mentioned applications. Electronic properties of polymers can be controlled to be insulating, semiconductive and conductive. Photonic properties include electro- and photo- induced luminescence, nonlinear optical and photovoltaic properties. Polymer is the enabling technology for the fabrication of today's microelectronics. Combining photolithography techniques with other polymer fabrication technologies such as printing, low cost flexible circuitry that are all polymer based are viable. Flexible electronic and photonic circuitries that include polymeric transistors, diodes, capacitors, light emitters and detectors, diode lasers, electronic and photonic interconnects are possible products of this technology. Through this research we seek to develop materials, and processing and fabrication methodologies that will allow the fabrication of conformal circuitries on flexible substrates. Research should focus on those materials that can combine the appropriate properties with the necessary processing characteristics for flexible electronic and photonic applications.

PHASE I: Synthesize or obtain material systems that possess the proper functional and mechanical properties, and processing characteristic for use in flexible devices. Conceptually demonstrate the feasibility of fabricating a flexible device or structure suitable for demonstration.

PHASE II: Using new materials, modify the material systems as necessary to optimize the properties. Investigate processing methodology for viable commercial development. A flexible device or structure suitable for demonstration will be fabricated to test the integration of the results of material research and processing investigation.

PHASE III DUAL USE APPLICATIONS: Flexible electronics and photonics have numerous private sector applications. The technologies addressed in this topic can be used in communications, computers, printers, household appliances, commercial electronics and display systems.

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2. C. P. Wong (ed.) Polymers for Electronic and Photonic Applications, Academic Press, 1993.

AF98T008 TITLE: Real Time Intelligent Coaching for Command and Control

KEY TECHNOLOLGY: Human System Interface

OBJECTIVE: Characterize the dynamic environments of command and control in terms of human decision making capacity and model the expert human decision making process over a range of scenarios that cover the environmental gamut. Propose effective means of intelligent coaching, to inform the operator about missing or bad decisions and develop benchmark tests of system performance for quantifying any benefits of intelligent coaching.

DESCRIPTION: Human error under severe cognitive workload can profoundly affect overall system performance in environments of real-time command and control. Bad or missing decisions, even as single events, can bring negative consequences ranging from missed opportunity to disaster. The military pace of operations is increasing, without clear understanding of the ways that operational success in faster tempos might depend on the ability of human decision makers to speed decisions without corresponding increase in decision errors. This topic seeks proposals to develop new job aiding interfaces based on multi-disciplinary approaches that combine formal understanding of a knowledge domain with effective tutoring of that knowledge. The technical challenges offered in this topic include (1) characterizing dynamic environments of command and control in terms of human decision making capacity, (2) modeling the expert human decision making process over a range of scenarios that cover the environmental gamut, (3) devising an effective means of intelligent coaching, to inform the operator about missing or bad decisions in these scenarios, and (4) discovering benchmark tests of system performance for quantifying any benefits of intelligent coaching. The long range goal is a system where human decision makers might be adaptively replaced by intelligent coaches without measurable loss of system performance. Multi-disciplinary approaches for this topic are explicitly encouraged, combining, for example, knowledge engineering descriptions of decision environments with the psychological understanding of adaptive tutoring systems. Environments for command and control decision making may be created under proposed efforts, but existing environments are available from Air Force laboratories and are encouraged.

PHASE I: Merge context sensitive decision aids with command and control workstation.

PHASE II: Quantify system performance increases resulting from intelligent coaching.

PHASE III: Any environment that relies on real-time human decisions about limited resource allocation with very low tolerance for error rate provides a candidate application domain. Such domains include: medical diagnosis and triage; industrial emergency response; crisis management, financial market investments, etc.

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1. Regian, J.W., & Shute, V. J. (Eds). (1992) Cognitive approaches to automated instruction. Hillsdale, NJ: Erlbaum.
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AF98T009 TITLE: Novel Mathematical/Computational Approaches to Surveillance Image Transmission and Exploitation

OBJECTIVE: Provide wide-ranging new capabilities in treatment of image data from surveillance and reconnaissance, enhancing ability rapidly to communicate and interpret such data, based on creative mathematical and computation innovations.

DESCRIPTION: The treatment of pictorial images has long relied on transform methods, especially in connection with their properties relative to statistical characteristics (stochastics) of the population of scenes, and the ambient environment. Insights from group theory and algebra, representations, function spaces and higher-dimensional geometry have already had an impact on both the computational feasibility of the transforms involved (e.g. Fourier, Karhunen, Walsh, Hadamard, Mellin and Hough transforms) and on the means of taking into account and compensating for statistical uncertainty. Further work in this area is needed, and proposals addressing progress here is encouraged. Suitable algebraic structures indicate how transform computations can be performed much faster (done in parallel). New types of generating bases for signal spaces are tools for improved image compression, reconstruction and feature identification. Geometric reasoning and database management of shapes permit drastic reduction in transmitted scene descriptors. The enhanced understanding arising from development of original mathematical relationships should lead to algorithms of greater power that realize more efficient and usable transmission, storage, and depiction of images that are obtained through surveillance both in peace and in conflict. Preference will be given to proposals that show evidence of mathematical depth as well as hands-on familiarity with applications of essential importance to the Air Force, and that convey a credible road-map or plan for technical insertion of results.

PHASE I: Develop a framework for algorithm development including published foundational results. Code an initial application on a low-level platform (such as a PC) to demonstrate feasibility of the concept.

PHASE II: Develop realistic image exploitation algorithms from the framework/methodology delineated in Phase I. Extend both the framework and the algorithms to deal with multiple sensing paradigms, data diversity, non-gaussian and malicious clutter environment, and a range of transmission channel requirements. Perform rigorous algorithm instantiation and testing using real-world field data.

PHASE III DUAL USE APPLICATIONS: Salient applications including secure and faithful encoding for wireless transmission of medical image or financial transaction information could be impacted. Commercial markets which involve space-based and aerial photography and radar sensing for economic, weather, and agricultural forecasting are expanding.

REFERENCES:

1. "Spatial Signal-Processing in Radars and Sonars", T. Kadota in Spatial Statistics and Digital Image Analysis, National Research Council Report, August 1993
2. "Wavelets in Signal Processing Applications", AFIT/AFOSR Joint Workshop Proceedings, 12-13 March, 1992

AF98T010 TITLE: Upgrading of PIC Codes for HPM Tube Design

OBJECTIVE: This effort seeks a mathematically and physically rigorous refinement and extension of existing plasma simulation codes (Particle-In-Cell Codes). The operational goal is the provision of an improved plasma simulation tool for high power microwave tube design.

DESCRIPTION: In present plasma simulations Maxwell's equations are used along with the Newton-Lorentz equations of motion. The latter routinely neglects the retarding force of the EM field carried along by the "particle" (the electron self-force) and this error is considerable at the high particle speeds common in HPM tubes. Another source of error in these tube design codes is secondary emission phenomena together with other tube boundary conditions. Finally, present plasma simulation methods partition a seamless physical interaction into separate components and no rigorous proof that the partitioned algorithm converges to a physically correct solution is available.

PHASE I: A persuasive strategy for numerically including the electron self-force into a PIC Code together with proper boundary conditions and a rigorous error analysis of both features.

PHASE II: A user-friendly commercially attractive code capable of doing HPM tube designs.

PHASE III DUAL USE APPLICATIONS: An appropriate commercial application for demonstration of the Phase II goals is the improvement (higher output and lower power consumption) of the magnetrons which drive microwave ovens and civilian radars.

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1. Yaghjian, "Relativistic Dynamics of a Charged Sphere", Springer-Verlag
2. Birdsall and Langdon, "Plasma Physics via Computer Simulation", Institute of Physics Publ
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AF98T011 TITLE: Innovative, Affordable Sensing For Aerospace Platforms

OBJECTIVE: Introduce innovative concepts into the research and design of current and future avionics sensor suites that can satisfy stringent life-cycle cost and functionality requirements.

DESCRIPTION: This topic area encompasses radio frequency (RF), electro-optic (EO), as well as multispectral sensors. Robust and novel sensing approaches are sought. Low cost per function and open architecture sensing is required. Some platforms will be operational for as much as 80 years, so approaches to maintain and modernize the sensor suite are required. All sensing approaches, including microwave and electro-optical sensing should be considered. Radiating and non-radiating sensing approaches are included. Adaptable analog and digital sensing components similar to Field Programmable Gate Arrays (FPGAs) in the digital world should be considered. Maximum use of commercial components is an approach to low cost, but the brief lifetime of commercial parts availability must be addressed. Sensing tasks to be performed include both Air-to-Air and Air -to-Ground target acquisition and identification. Aircraft, unmanned aerial vehicles (UAVs), and space-based sensors should be considered. Acquiring and identifying difficult targets that are concealed, camouflaged or low observable should be considered. Remote novel sensing approaches for targets that are under bridges, under foilage, or even underground, are desired.

PHASE I: Develop the novel sensing approach through quantitative models, design, or schematics, as applicable. Generate breadboard-level, proof-of-concept demonstrations or virtual prototype incorporating realistic data.

PHASE II: Conduct advanced demonstrations of novel sensing techniques using real data. Demonstrate feasibility for specific field application for both a military and commercial market.

PHASE III DUAL USE APPLICATION: The goal of open-architecture subsystems and low cost per function enhance the applicability of these novel sensing techniques for various commercial markets. Applications include biomedical imaging, remote sensing for environmental hazards, automobile sensors (e.g. collision avoidance), and commercial communication systems.

REFERENCES:
1. "Study Sees USAF Based On Esoteric Technologies", Aviation Week Space Technology, 19 August 1996, v. 145, no. 8, p 80.
2. "A Systems Engineering Approach to Aircraft Kenetic Kill Countermeasures Technology: Development of an Active Aircraft Defense System for the C/KC-135", AFIT Thesis AFIT Reference AFIT/GSE/ENY/95D-01, ADA306012, Approved for Public Release
3. "Registration and High Resolution Reconstruction of Multi-Frame Low-Resolution, Aliased Infrared Images", SPIE Passive Sensors Conference Proceedings, April 1996.
4. Wright LaboratorySensor Technology Branch (WL/AAJT) Home Page (Public Release Articles with Abstracts) at http://www.aa.wpafb.af.mil/aanew/aaj/aajt/index.html

AF98T012 TITLE: Automatic Target Recognition And Sensor Fusion Research

OBJECTIVE: Develop automatic target recognition and sensor fusion approaches that are robust to difficult conditions, scale with problem complexity, and have tractable training requirements.

DESCRIPTION: Machine aided or automatic target detection and recognition needs an approach grounded in fundamental single and multi-sensor phenomenologies. This basic approach contributes to a future ability to identify difficult targets (e.g., adverse weather, obscured, camouflaged, articulated, . . .) over large areas to support timely sensor to shooter operations. Methods which develop affordable sensor solutions by balancing sensor complexity across single and multi-sensor approaches are desired. Further, methods which address robust to difficult conditions, scale with problem complexity, and have tractable training and testing requirements are of fundamental interest. To achieve these important objectives, approaches with a strong model-based component should be developed in such a way that limited testing can be used to validate the underlying model assumptions (theoretical basis) of the approach. This will build confidence that the approach will work in conditions that are not testable due to the extreme complexity of the real world conditions.

PHASE I: The first phase of the program should result in a paper design of a single/multi-sensor ATR algorithm suite that can demonstrate, either theoretically or via simulation, that the objectives of robustness, scalability, and tractable training/testing requirements can be met. Quantitative estimates that show advantages of proposed approaches in terms of amount of measured data required to support approach, memory requirements (e.g., storage requirements for target templates), and computational requirements (e.g., number of operations required to classify target for a typical but clearly defined problem) are desired. This design will be implemented and tested in Phase II.

PHASE II: Algorithms will be developed, tested and delivered to the government for evaluation and incorporation into automatic target recognition and fusion testbeds. Algorithms should be tested with a combination of synthetic and measured data provided by the government. The algorithms should be delivered for government integration and installation.

PHASE III DUAL USE APPLICATIONS: Automatic target recognition and fusion approaches have significant application in the fields of medical imaging, remote sensing, automated manufacturing and inspection, traffic control, and law enforcement. Algorithms developed as result of this effort will likely support these and other applications where sensing and process control are key technical elements.

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1. T.D. Ross, L. Westerkamp, E.G. Zelnio, T.J. Burns, "Extensibility and other model-based ATR evaluation concepts," Algorithms for Synthetic Aperture Radar Imagery IV, Proc. SPIE 3070, Vol. 3070
2. E. Zelnio, F. Garber, L. Westerkamp, S. Worrell, J. Westerkamp, M. Jarratt, C. Deardorf, P. Ryan, "Characterization of ATR Systems," Algorithms for Synthetic Aperture Radar Imagery IV, Proc. SPIE 3070, Vol. 3070

AF98T013 TITLE: Military Essential Electron Device Development

OBJECTIVE: Develop the fundamental materials techniques, models and tools required for advancing electron device technologies.

DESCRIPTION: While many advanced electron devices require the assets of a large company for their manufacture, there are supporting technologies such as epitaxial wafers, modeling/simulation/design tools, and fabrication services which are often provided by small businesses. There are also some cases in which small businesses do manufacture the device types of interest. These include, but are not limited to: microwave/millimeter wave power amplifiers and integrated circuits; high speed/high resolution/high accuracy/broadband analog to digital converters; infrared and/or ultraviolet detectors, focal plane arrays and lasers; and highly microminiaturized components, consisting of electronic chips and devices combined via advanced multi-chip module packaging techniques. The technical limitations of such devices often stem from such diverse areas as fundamental materials growth and evaluation techniques, basic photo-electro-thermo-mechanical models, fundamental device models, design tools and environments, basic device processing techniques, and test and analysis. Advancement of the frontiers in these basic sciences and technologies has historically enabled similar advances in commercial technologies across a broad front of devices which have found applications in consumer electronics. Examples of potential projects in this broad area might include application of advanced materials to conventional devices to achieve higher performance or yield, development of needed modeling or design tools, or development of processes for reducing the cost of devices or module chip modules.

PHASE I: Demonstrate proof-of-principle for advancement of one or more of the limiting factors.

PHASE II: Develop a prototype sufficient to identify and resolve any key problems that might impede successful adaptation of the advancement of one or more of the limiting factors.

PHASE III DUAL USE APPLICATIONS: Commercial applications could include high bandwidth communications systems, automotive radar, intelligent highway sensor systems, wireless local area network electronics, high density data storage, surgical devices, high speed printing, and commercial avionics.

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1. A. Cho, "Advances in Material Processing and Device Fabrication," presented at the 2nd International Semiconductor Device Research Symposium (ISFRS '93), pp. 7-8 (1993).
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5. B. Glance, et al., "Fast Frequency-Tunable External-Cavity Laser," Electronics Letters Vol. 23, No. 3, pp. 98-99, 20 Jan 97.

AF98T014 TITLE: Simulation-Based Design System for Multi-Stage Manufacturing Processes

OBJECTIVE: Develop a computer-aided approach for the design of reliable and affordable manufacturing processes for difficult-to-form materials that considers alternative materials, sequences of processes, and process parameters.

DESCRIPTION: Manufacturing of components for new aircraft systems such as the F-22 and spare components for aging aircraft systems offers great opportunity to introduce innovative material process design methods which consider alternative processing approaches and can lead to significant improvements in component reliability and affordability. Of particular interest is the development of computer-aided design tools that enable the standardization and optimization of the supply chains for parts used by Air Force systems while conforming to proven principles for the design of material processes. This effort will involve the formulation of materials and processing models and their use with simulation and optimization-based design techniques in order to determine processing sequences and parameters that optimize the manufacturing process with respect to quality, performance, and cost.

PHASE I: Demonstrate feasibility of obtaining and utilizing materials and process models in a computer-aided design system that can evaluate, for optimization, alternative processing sequences for product quality, cost, performance, and delivery time. Develop a feature-based framework for modeling and optimization that allows for the addition of new material, process models, and optimization algorithms. Develop methods based on shape optimization for the standardization of billets and intermediate shapes for metal forming of multiple final shapes. Verify the capabilities of developed tools by using models for the manufacturing of aircraft components such as turbine disks.

PHASE II: Develop a prototype design system capable of evaluating alternative thermal, mechanical, and/or chemical processes for the production of net-shape components from difficult-to-form materials. The design system's user interface will make extensive use of visualization features. Verify process design system capabilities by optimizing for cost, quality, performance, and delivery time, the manufacturing of engine and structural components.

PHASE III DUAL USE APPLICATIONS: This exploratory research is foreseen to be used in both military and commercial applications for the design and optimization of material, shape, and processing aspects of manufacturing from high performance metals, ceramics, and polymers. Immediate benefits will be obtained from the application of shape optimization techniques to the standardization and optimization of the Air Force supply chain. A specific example includes minimizing the number of billet types and blocker dies involved in forging different turbine disks for all Air Force systems.

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AF98T015 TITLE: Carbon Nanotube Materials for Air and Space Applications

OBJECTIVE: Develop novel carbon nanotubes for macro-to-submicro applications

DESCRIPTION: A strong effort in the synthesis and theory of fullerene nanotubes is very timely [Physics Today, June & September 1996; C&E News, July, 1996, American Scientist, July, 1997]. The unique mechanical and electronic properties of this new class of materials enable a wide variety of potential technological applications, especially new composite materials for spacecraft and aircraft of interest to the United States Air Force. Doubling of the stiffness of the fiber accompanied by a corresponding decrease in weight, may enable a significant reduction in cost of materials. Indeed, the development of "molecular composites" which has been recognized as critical for Air Force applications for many years, has eluded the technological community so far. Moreover, tubular ropes would enable the use of such high strength materials for space applications. A broad spectrum of additional applications encountered at the micro to nano level are also of potential interest, for example, as future submicroelectromechanical (MEMS) systems.

This project is to develop and apply the challenging technologies to grow and process carbon nanotubes as required, as well as providing a strong theoretical basis, combining first principles, atomistic simulations and continuum-shell models. This will allow the handling of large systems and identification of general relationships [Yakobson et al., Physical Review Letters "Nanomechanics of Carbontubes" 76, 2511 (1996)] to enable the prediction of properties and the design of nanotubes of defined structures. For example, the proposed project will address the prediction of properties of multiwalled nanotubes, which depend critically on the interlayer coupling via van der Waals interactions, in contrast to the single-shell tubes. Similarly, the inter-tubular interactions in ropes [Smalley et al., Science, "Crystalline ropes of metallic carbon nanotubes," 273, 483 (1996)] as well as the tubule-matrix interactions in composites, are largely due to vdW forces, which have to be incorporated in the molecular dynamics model.

PHASE I: Design, synthesize and demonstrate feasibility and manufacturability of fullerene nanotubes with improved properties.

PHASE II: Design, synthesize and characterize an expanded series of carbon nanotubes based on proof of principle studies in Phase I.

PHASE III DUAL USE APPLICATIONS: This technology will have broad commercial applications involving, among others, air and space structures, microelectronics, and submicroelectromechanical (MEMS) systems.

AF98T016 TITLE: Evanescent Fields for High-Speed, Non-intrusive Materials Processing and Assessments

OBJECTIVE: Develop a capability for fast, reliable and affordable morphologic and topographic material process monitoring and assessment.

DESCRIPTION: Recent advances in sensor technology (e.g., in situ remote raman, IR, optical emission spectroscopy, chemical sensing, etc.) have made significant contributions to real-time monitoring and control of material (gas, liquid, and solid) composition and phase. New sensor technologies (in particular, spectroscopic methods) are moving in situ process monitoring from macroscopic energy measurements of temperature and pressure toward more nano-scale crystallographic data providing more fundamental, broad-based information for deriving and/or inferring in situ material behavior and resultant properties. Such remote, non-intrusive methods are also needed for both in situ morphology and topographic mapping of 2D and ultimately 3D films, as well as post process for fast, reliable, and affordable damage assessment of aerospace system structural integrity. Evanescent fields are used in scanning tunneling microscopes in the form of evanescent electron wave functions achieving atomic-scale topological resolution. Evanescent fields are also used in scanning near field optical microscopes achieving resolutions on the order of 10-100 Angstroms using a light with 6000 Å (red) wavelength. Evanescent fields provide a means of interaction through an interface, and they usually yield very high resolution in excess of the Abbe barrier. The need exists for a high-speed, portable, lightweight, harsh environment (500 C) evanescent field probe, that can be used, either handheld or via robotic manipulator, to characterize surface and subsurface texture variations in thin-films, and to detect various types of degradation and/or discontinuities in bulk materials, e.g., bondline degradation in polymeric composites and metal fatigue cracks in turbine engine components. The challenge is to transfer evanescent field technology from laboratory material characterization applications to a cost competitive material process monitoring and/or assessment capability.

PHASE I: Demonstrate the feasibility of material monitoring and/or assessment across a broad range of temperature, processing and operating conditions to monitor morphology, flaws and stresses of thin-film and structural materials. Performance enhancement films of replacement components for aging aircraft to include high temperature intermetallics, composites, and inorganic electro-optical materialsare immediate interest.

PHASE II: Develop a cost-competitive, fast and reliable capability for near real-time monitoring and/or assessment across a broad range of processes and conditions to monitor morphology, flaws and stresses of thin-film and structural materials.

PHASE III DUAL USE APPLICATIONS: Dual use of this exploratory research is foreseen for the process monitoring and post process assessment of aerospace materials. More specifically, thin-films for extreme environments such as thermal and wear protection for automotive, aircraft, and/or space propulsion systems. Specific examples include morphologic and topographic monitoring of thin-film or bulk material surfaces, and for coating, cleaning or inspecting of aircraft components.

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AF98T017 TITLE: Polymeric-Based Materials and Polymer-Nanocomposites for Thermal Management and Electrical Signal Distrubtion of USAF Satellites and aircraft

OBJECTIVE: Develop a new generation of polymer-based materials and nanocomposites for thermal management and electrical signal distribution for USAF satellites and aircraft.

DESCRIPTION: Proper thermal management and efficient electrical signal distribution are critical for successful operation of USAF systems in all environments and theaters. However, many current approaches for thermal management rely on metallic heatsinks whose excess weight decreases operational payload. Likewise, existing approaches for electrical signal distribution rely on wires consisting of highly conductive metals such as copper, silver or metallic alloys whose high density, e.g. 10.5 g cm-3 for silver and 8.96 g cm-3 for copper, is undesirable for applications in space and aerospace vehicles where weight savings are important. It has been attempted to replace the 22 gauge copper wire currently used in aerospace vehicles with a smaller 26 gauge or 30 gauge wire, but the thinner wires do not have the necessary mechanical strength and durability and therefore cannot be used. Nevertheless, these metals afford the highest conductivity (approximately 6x105 S cm-1 at room temperature) for power, signal and EMI shielding applications

In an attempt to address these limitations, considerable research effort during the past twenty years has been spent on conducting polymers. Conjugated polymers such as polyacetylene, polythiophene and polypyrrole have been introduced with electrical conductivity up to 105 S cm-1 by chemical and electrochemical doping. However, these highly conductive doped conjugated polymers are environmentally unstable, exhibit poor mechanical properties and, therefore, have found limited applications, or none where high conductivity is required.

New materials technologies are sought which can give thin, highly conductive, low density wires compared with conventional coating and plating technologies or materials incorporating micron-sized metallic fillers. The main advantage to systems is the replacement of metal signal wires in existing aircraft and satellites resulting in a substantial weight savings, improved reliability and enhanced system performance. Other outlets include EMI shielding and grounding. The resulting technology should offer high thermal conductivity as well for thermal management applications.

PHASE I: Demonstrate innovative materials technologies which offer highly conductive (> 10**3 S/cm) wires or fibers having dramatically reduced densities from copper or silver. The wires must have adequate tensile strength (> 350 ksi) and modulus (> 10 msi) as well as thermal and environmental stability.

PHASE II: Demonstrate and develop continuous production capability of materials technologies demonstrated in Phase I. Establish consistent production criteria to give reproducible properties and produce ample material for AF testing.

PHASE III DUAL USE APPLICATIONS: Successfully demonstration would offer a tremendous potential for substantial weight savings on commercial aircraft and improved reliability of many consumer electronics.

AF98T018 TITLE: Weapon Flight Mechanics

OBJECTIVE: Demonstrate microelectromechanical aerodynamic flow control and develop neural network hypersonic aerodynamic prediction capability.

DESCRIPTION: Recent work in the application of Microelectromechanical Systems (MEMS) devices to aerodynamics has shown that MEMS devices have the potential to control air vehicles by manipulating the flow in the thin boundary layer attached to the aerodynamic surface. While micro-machining technology has enabled the miniaturization of sensors and actuators (small flaps) with high spatial and temporal resolution, lacking are self contained integrated systems of sensors, actuators, and processors to carry out real time flow control. The purpose of this research effort is to demonstrate the feasibility of integrating microsensors, microactuators, and decision-making microelectronics logic into the skin of an air vehicle to reduce drag and control the aerodynamic forces and moments on the body. The proposed technology will facilitate the development of next generation super-maneuverable air vehicles. A hypersonic weapon system will require the generation of extensive aerodynamic data through a combination of wind tunnel testing, computational fluid dynamics (CFD), and flight testing. However, flight testing of hypersonic vehicles at hypersonic velocities is extremely expensive, in some cases exceeding ten million dollars per flight. Researchers must depend on engineering analysis tools for preliminary design and CFD for advanced analysis. These techniques have limitations of their own. A thorough aerodynamic and aerothermodynamic analysis of hypersonic weapons will require a suite of data collection/ generation methods to provide a complete database. Development of a neural network based hypersonic prediction method will allow an efficient method to provide accurate aerodynamic prediction.

PHASE I: Provide fundamental understanding of the MEMS based aerodynamic measurement and control approach. The goal of the neural network research is to provide a capability of predicting hypersonic aerodynamic forces and moments on simple geometries.

PHASE II: Design and fabricate a self sustained distributed network of totally integrated MEMS devices on an air vehicle. Phase II for the neural network research is to conduct predictor training and validation using existing database on complex geometries.

PHASE III DUAL USE APPLICATIONS: The technology developed in this program has many commercial and military applications. MEMS technology could be used to develop weapon systems that do not need traditional aerodynamic control surfaces. This could lead to increased speed, range, and survivability of these systems. In the area of commercial aircraft safety, MEMS devices could be used to sense the onset of stall and prevent flow separation from wings and tail surfaces. This could aid in the prevention of airplane crashes. Neural network research could also aid the commercial aircraft arena, through improved simulation capability of flight performance.

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AF98T019 TITLE: Sensor Concepts for Autonomous Guidance

OBJECTIVE: Develop innovative sensor concepts for guidance technologies for air deliverable autonomous munitions.

DESCRIPTION: The Advanced Guidance Division of the Wright Laboratory Armament Directorate seeks new and innovative ideas/concepts in areas associated with sensors/seekers for guidance and control applications for autonomous precision guided conventional munitions: electro-optical, millimeter-wave, and radio-frequency seeker technology and the components and signal processing systems used in such seekers. This includes, but is not limited to, sources, detectors, polarization-sensing elements and systems, modulators (both single element and pixelated), pattern recognition and processing systems, and basic material and device development for accomplishing all of these; and innovative signal and image processing algorithms used, for example, in synthetic-aperture radar (SAR), millimeter-wave (MMW), imaging infrared (IIR), and laser radar (LADAR), needed to autonomously detect, recognize, classify and identify target signatures embedded in sensor data. Sensors, algorithms, and integrated seeker concepts capable of processing/fusing multi-sensor data are of particular interest. Concepts must have dual use/commercialization potential.

PHASE I: Determine the technological or scientific merit and the feasibility of the innovative concept.

PHASE II: Produce a well defined deliverable product or process.

PHASE III DUAL USE APPLICATIONS: The military end products or processes resulting from this topic will be used to develop electro-optical, millimeter-wave, radio-frequency seeker technology, and the components and signal processing systems used in such seekers for autonomous guided munitions. A wide range of commercial products could be produced from this research. Typical applications include real-time imaging, machine vision, robotics, telemedicine, object recognition, telesurveillance, spectral medical imaging, remote sensing, laser cutting, molding and medicine. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

AF98T020 TITLE: Ordnance Technologies for Advanced Munitions

OBJECTIVE: Develop and demonstrate technologies for enhancing existing munitions while providing a product for advanced munition applications.

DESCRIPTION: Ordnance technologies which reduce cost and support requirements, while improving performance, are needed for improving existing munitions and enabling future weapons. Technologies of interest support fuze, warhead and explosive technology advancements. Technologies of primary interest are: fuzing technologies which improve firing capacitors energy densities through the use of dielectric films developed from blending polymers with ceramic nanoparticles, processes for determining the mechanical properties of explosives and supporting test procedures and equipment, Metallic Oxide Semiconductor (MOS) thyristor based high power, fast rise time switches for use in munition firesets, technologies for controlling the terradynamic trajectories of geological probes and technology for demilitarization of high explosives using molten salt catalyst processes.

PHASE I: Complete design and laboratory or breadboard demonstration of technology.

PHASE II: Fabricate and test prototype devices, hardware and processes; deliver product for government testing.

PHASE III DUAL USE APPLICATIONS: Military applications include producing more effective munitions and lower collateral damage, that is it supports the Air Force precision engagement core competency . Commercial applications include compact, portable high voltage power supplies; processes for safety qualification of commercial explosives; switch mode power supplies for lasers, radars, and televisions; commercial earth resource monitoring devices; and hazardous medical, municipal, and organic waste elimination.

REFERENCES:

1. "Blunt Cylinder Impact Tests for the Determination of Constitutive Equations of Explosives", 15th International Symposium of Ballistics, Jerusalem, Israel, 21-24 May 1995.
2. "Lock-on Effect in Pulsed-power Semiconductor Switches", Journal of Applied Physics, 15 Mar 92, Volume 71, page 3036.
3. "500 Volt IGBTs Useful in High Voltage Hard Switching Applications", Electronic Design Magazine, Analog Applications Issue, Jun. 94.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Proposal Submission

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

The topics published in this solicitation are broad in scope. They were developed to bring the small business community and research partners together to meet the technological needs of today. DARPA has identified 7 technical topics, numbered **DARPA ST98-001** through **DARPA ST98-007** to which small businesses may respond in the fiscal year (FY) 98 solicitation. Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. Full topic descriptions, which originated from DARPA technical offices, are included.

Please note that **5 copies** of each proposal must be mailed or hand-carried; DARPA will **not** accept proposal submissions by electronic facsimile (fax). A checklist has been prepared to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

It is expected that the majority of DARPA Phase I awards will be Firm Fixed Price contracts. Phase I STTR proposals **shall not exceed $99,000**, and are for approximately one (1) year efforts. DARPA Phase II proposals must be invited by the respective Phase I technical monitor (with the exception of Fast Track Proposals - see section 4.5). Phase II STTR awards will be limited to $500,000, and it is expected that a majority of the Phase II contracts will be Firm Fixed Price-Level of Effort.

The responsibility for implementing DARPA's Small Business Technology Transfer (STTR) Program rests with the Office of Administration and Small Business (OASB). The DARPA SBIR/STTR Program Manager is Connie Jacobs. DARPA invites small businesses, in cooperation with a researcher from a university, an eligible contractor-operated federally-funded research and development center (FFRDC), or a non-profit research institution, to send proposals directly to DARPA at the following address:

DARPA/OASB/STTR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714

(703) 526-4170
Home Page http://www.darpa.mil

STTR proposals submitted to DARPA will be processed by DARPA OASB and distributed to the appropriate technical office for evaluation and action.

DARPA selects proposals for funding based on technical merit and the evaluation criteria contained in this solicitation document. DARPA gives evaluation criterion a., The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution." (refer to section 4.2 Evaluation Criteria - Phase I - page 7), twice the weight of the other two evaluation criteria. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

In order to ensure an expeditious award, cost proposals will be considered to be binding for a period of 180 days from the closing date of this solicitation. For contractual purposes, proposals submitted to DARPA should include a statement of work which does not contain proprietary information. Successful offerors will be expected to begin work no later than 30 days after contract award. For planning purposes, the contract award process is normally completed within 30 to 60 days from issuance of the selection notification letter to Phase I offerors.

On a pilot basis, the DoD STTR program has implemented a streamlined Fast Track process for STTR projects that attract matching cash from an outside investor for the Phase II STTR effort, as well as for the interim effort between Phases I and II. Refer to Section 4.5 for Fast Track instructions. DARPA encourages Fast Track Applications to be submitted during the last two months of the Phase I effort. Technical dialogue with DARPA Program Managers is encouraged to ensure research continuity during the interim period and Phase II. If a Phase II contract is awarded under the Fast Track program, the amount of the interim funding will be deducted from the Phase II award amount. It is expected that interim funding will not exceed $40,000.

DARPA FY 1998 Phase I STTR
Checklist

1) Proposal Format

   a. Cover Sheet - Appendix A (identify topic number) ______

   b. Project Summary - Appendix B ______

   c. Identification and Significance of Problem or Opportunity ______

   d. Phase I Technical Objectives ______

   e. Phase I Work Plan ______

   f. Related Work ______

   g. Relationship with Future Research and/or Development ______

   h. Potential Post Applications ______

   i. Key Personnel ______

   j. Facilities/Equipment ______

   k. Subcontractors/Consultants ______

   l. Prior, Current, or Pending Support of Similar Proposals or Award ______

   m. Cost Proposal (see Appendix C of this Solicitation) ______

   n. Company Commercialization Report (see Appendix E of this Solicitation) ______

   o. Agreement between the Small Business and Research Institution ______

2) Bindings

   a. Staple proposals in upper left-hand corner. ______

   b. **Do not** use a cover. ______

   c. **Do not** use special bindings. ______

3) Page Limitation

   a. Total for each proposal is 25 pages inclusive of cost proposal and resumes. ______

   b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

4) Submission Requirement for Each Proposal

   a. Original proposal, including signed Appendices A and B. ______

   b. Four photocopies of original proposal, including signed Appendices A and B. ______

INDEX OF DARPA FY 1998 STTR TOPICS

DARPA ST98-001 Biologically-Grounded Nonlinear Optical Pulse Generator

DARPA ST98-002 Optical Frequency Conversion for Efficient Blue Light Sources

DARPA ST98-003 Neutralization/Decontamination of Biological Warfare (BW) Pathogens

DARPA ST98-004 Microrover Technologies for Tactical Land Warfare

DARPA ST98-005 Micro Air Vehicle (MAV) Guidance and Navigation

DARPA ST98-006 Low-Cost, Miniature, Unattended Magnetic and Chemical Sensors Systems

DARPA ST98-007 Universal, Windows Based, High Speed Data Acquisition and Control Graphical User Interface System

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DARPA ST98-001 TITLE: Biologically-Grounded Nonlinear Optical Pulse Generator

CRITICAL TECHNOLOGIES AREA: Electronics

OBJECTIVE: Develop optical microsystems for biologically-based pulse generators using nonlinear optical materials, with the overall goal of low-cost, lightweight, high density kernel-based parallel computational systems.

DESCRIPTION: The biological neuronal systems' computational capability is in part due to its use of massively parallel kernel-based processing algorithms. These can be simulated on digital machines and shown to be very powerful and versatile algorithms. However, the simulations are very slow and in many cases it is impractical to fully incorporate the full algorithms. Although the biologically-based algorithms are very effective, they are of limited use because there is no "hardware" for them. Electronic implementations invariably encounter the interconnect problem (too many wires) while standard optical implementations can handle the interconnects and even the adaptation, but must rely on electronics for signal generation and detection. The objective here is to take advantage of basic nonlinear optical effects and build an all-optical pulse generator. The baseline generator is the integrate-and-fire model. It requires a first-order relaxation effect and then a fixed threshold followed by a fast discharge. These correspond, for example, to incoherent phospher excitation or perhaps photorefractive induction, an optically bistable gate for the threshold, and multilevel nonradiative decay modes for the discharge.

PHASE I: Determine candidate linear, nonlinear, coherent, and/or incoherent optical effects corresponding to a biologically-grounded pulse generator system, with the constraint that the pulse effect be primarily a composite optical material effect. Fabricate proof-of-principle discrete pulse generators and evaluate their performance. Deliver all designs, analyses, and the pulse generators.

PHASE II: Design and build a high density, spatially continuous, optical pulse generator slab of at least 106 equivalent pixels. All work products of Phase II are deliverables.

PHASE III DUAL USE APPLICATIONS: This will provide an entirely new information processing platform based on biological neuronal systems, not only in the algorithmic approach, but in the underlying physical implementation. It will have applications in automatic object recognition, speech generation and recognition, and in adaptive control systems.

REFERENCES:
"Pulse-Coupled Neural Nets: Translation, Rotation, Scale, and Intensity Signal Invariances for Images," John L. Johnson, published in Applied Optics, Vol. 33, 6239 (1994).

DARPA ST98-002 TITLE: Optical Frequency Conversion for Efficient Blue Light Sources

CRITICAL TECHNOLOGIES AREA: Electronics

OBJECTIVE: The objective of this task is to develop new, non-traditional methods for harmonic generation of blue laser light in nonlinear materials. Proposals are sought on methods other than the conventional techniques of optical frequency conversion using angle tuning of a bulk crystal for phase matching or periodic poling to achieve quasi-phase matching.

DESCRIPTION: Efficient generation of blue laser light has important applications ranging from optical data storage to submarine communication links. For example, the data storage capacity of commercial CD-ROM's would quadruple if the wavelength of the laser diode could be reduced by a factor of two. Although research in the field of second harmonic generation has been active since the advent of the laser, efficient and robust frequency up-conversion units for low-power laser diodes are not available. A review of the field of nonlinear optical frequency conversion was recently published in Physics Today (See References).

The task is to develop novel methods of frequency up-conversion for generation of blue laser light. Device modeling and prototype development should use currently available nonlinear materials which have long term stability. The frequency up-conversion devices should occupy a small volume and be compatible with packaging requirements found in laser diodes.

PHASE I: Demonstrate the fundamental technologies required to produce efficient, robust frequency conversion devices using currently available nonlinear materials.

PHASE II: Develop efficient, robust frequency conversion devices which are compatible with laser diode packaging requirements.

PHASE III: Package a device array of blue light sources capable of high output power.

DUAL USE APPLICATIONS: Both military and civilian organizations have a need for more compact information storage. One military application is in field manuals for equipment, system drawings, and items of supply. Increased capacity for CD-ROM storage means fewer disks must be stored and protected, larger files can be placed on disk, and more video and audio information can be included in maintenance manuals (electronic version). A second use is for underwater communications: Since blue-green lasers can penetrate sea water for some distance, these devices could be utilized for covert underwater communications between seal teams or other entities. Ultimately, if higher power versions can be developed, this technology supports communications with the submarine fleet. The same advantages accrue to civilian applications. Without major changes in formatting or other expensive development, the capacity of disks can be increased. Longer programs can be placed on single disks or alternatively, the disk can be made smaller for the same information. The devices will also find application in multi-colored displays.

REFERENCES:
1) M.M. Fejer, Physics Today, May issue, p.25 (1994).

DARPA ST98-003 TITLE: Neutralization/Decontamination of Biological Warfare (BW) Pathogens

CRITICAL TECHNOLOGIES AREA: Chemical and Biological Defense

DESCRIPTION: The decontamination of personnel (including surface decontamination of skin and clothing of individuals who may have been exposed to agents), environmental areas, equipment, and facilities that have been exposed to biological warfare agents remains an essential concern. The capability to neutralize agents during an attack is also desirable. Current approaches for neutralization/decontamination utilize corrosive chemicals or require large energy sources, hence, they are not suitable for field applications where low-power consumption, portability, and compatibility with materials are essential. Current decontaminating solutions are often corrosive or toxic and require a large amount of water or other solvents, which are difficult to transport; may not always be readily available in the necessary quantities; and may generate large quantities of effluent.

DARPA seeks innovative concepts for neutralization of BW agents and decontamination of surfaces or personnel. Suitable technologies must be effective against a wide variety of agents; eliminate all detectable agent on the treated areas or surfaces; have low-power requirements; be compatible with skin, tissue surfaces, and equipment; and (if fluid based) use minimal amounts of liquid with little or no effluent.

PHASE I: Identify a suitable technology and determine the feasibility of the chosen approach with preliminary demonstration of efficacy against one or more model pathogens.

PHASE II: Demonstrate feasibility and safety in a model system with several appropriate pathogens of different classes.

PHASE III DUAL USE APPLICATIONS: The ability to decontaminate an area, to eliminate pathogens in the environment, or to sterilize a body surface would have a variety of important uses in both military and civilian medicine, as well as in agriculture. For example, the technology could be used to maintain sterile environments in hospitals and clinics, and to set up sterile surgical areas under field conditions. The potential uses for this technology will increase as pathogens in hospitals become increasingly resistant to widely used disinfectants and antimicrobial agents.

DARPA ST98-004 TITLE: Microrover Technologies for Tactical Land Warfare

CRITICAL TECHNOLOGIES AREA: Surface/Under Surface Vehicles/Ground Vehicles

DESCRIPTION: DARPA is seeking the design, development, and evaluation of microrover technologies that will enable unique and unprecedented abilities to conduct tactical warfighting operations. It is expected, but not required, that the novel warfighting abilities will be derived from the small size of the microrover, for example, by enabling it to reach destinations or perform tasks not otherwise possible. General areas of interest include innovative mobility systems and innovative on-board control systems. For the purposes of this solicitation, a microrover measures no more than 100 cm on any side.

Specific areas of interest include (but are not limited to) the following: a) Mobility systems capable of land travel, including surface, buildings, and the ability to be air-dropped; b) Mobility systems capable of travel in sewers and utility tunnels; c) On-board sensing and perception for the purposes of avoiding obstacles and seeking goals. All sensing modalities meeting microrover power and size constraints will be of interest, including (but not limited to) machine vision, machine audition, radar, and ladar. All perceptual interpretation approaches consistent with microrover computational resources will be of interest.

Specific areas of limited interest include (but are not limited to) the following: a) Mobility systems based on existing designs and approaches, when such systems do not contain substantially innovative technology; b) Algorithms for planning trajectories, paths, or routes, when such algorithms are not integrated into a microrover system; c) Algorithms for task-level control, learning, or higher-level reasoning, when such algorithms are not integrated into a microrover system; d) Algorithms for collaboration and cooperation between multiple microrovers.

PHASE I: Develop and demonstrate mobility and on-board control system breadboards.

PHASE II: Develop, demonstrate, and deliver mobility and on-board control system brassboards. Conduct tests to quantify performance. Deliver complete documentation of test procedures, cases, and results.

PHASE III DUAL USE APPLICATIONS: Environmental cleanup, disaster relief, search and rescue, law enforcement, and drug interdiction.

DARPA ST98-005 TITLE: Micro Air Vehicle (MAV) Guidance and Navigation

CRITICAL TECHNOLOGIES AREA: Microrobotics

OBJECTIVE: Develop and demonstrate innovative guidance and navigation systems for Micro Aerial Vehicles (MAVs) which utilize on-board processing, memory, communication, and sensing capabilities of MAV systems in combination with ground station capabilities. Concepts should address maneuvering of MAVs in complex environments such as urban canyons and interior spaces where collision avoidance with objects and barriers will require use of sensor feedback and innovative, intelligent control approaches. Navigation systems will require position determination technology such as multiple transmitter/receiver triangulation, micro-miniaturized inertial navigation systems, micro-GPS, or other.

DESCRIPTION: MAV's will be at least an order of magnitude smaller than current flying systems (less than 15 cm in length, width or height) and will serve as six degree-of-freedom sensor platforms providing unprecedented situational awareness to the individual soldier in the field. Potential military missions for MAV's include surveillance and reconnaissance over diverse terrain, including such confined areas as urban canyons and interior spaces. It may be assumed for this study that the MAV has a robust flight vehicle stability and control system.

To facilitate MAV operation in combat, it is desirable to have control of the MAV at a level where one directs its placement with simple instructions. This requires the ability to determine location (navigation), and the ability to follow a path to move the MAV from current location to desired location (guidance) with a user friendly interface. The guidance must also consider feedback from sensors to perform collision avoidance maneuvers while trying to reach a waypoint or objective.

Algorithms or agents are necessary to transform these simple commands into MAV guidance and navigation functions. Additionally, the guidance and navigation functions can be allocated to MAV on-board processing and ground station interface systems. However, the architecture should be sufficiently robust to tolerate MAV communication black-outs, interruptions and/or MAV control hand-offs to other ground stations. Operations in confined spaces of urban environments and building interiors requires the system to integrate ultrasonic, imaging, or other advanced sensor techniques that supply local situational information to the navigation and guidance components.

PHASE I: Develop guidance and/or navigation strategies and distributed processing architectures for vehicle and ground processing functions. Develop a software architecture evolutionary path for function allocation of guidance and navigation components between the MAV and ground station processors. Develop the preliminary guidance and or navigation system design, including sensors. Identify key attributes of system design following the estimates of the architecture evolutionary path, including navigation system accuracy capabilities and sensitivities, collision avoidance sensor requirements, guidance performance metrics, MAV and ground station on-board processing, memory, and communication requirements. Identify anticipated system trade-off issues and describe expected system performance characteristics. Identify high-risk elements of the proposed design.

PHASE II: Define guidance and/or navigation system features, including processors, software components, and external system interface requirements. Develop final design; fabricate; test; and demonstrate operation of the proposed system(s). An aerial demonstration with a suitable small vehicle (which may exceed 15 cm for purposes of demonstrating guidance and navigation functions) is desirable, but not essential. Conduct post-demonstration analysis sufficient to indicate performance of the proposed system and its suitability for integration into full MAV systems.

PHASE III DUAL USE APPLICATIONS: The development of MAV guidance and navigation systems will be useful in commercial surveillance systems. MAVs have high potential for applications in crime prevention, security systems, drug interdiction, bio-chemical hazard detection, and reconnaissance wherever conditions may be hazardous to personnel.

DARPA ST98-006 TITLE: Low-Cost, Miniature, Unattended Magnetic and Chemical Sensors Systems

CRITICAL TECHNOLOGIES AREA: Sensor Systems

OBJECTIVE: Develop and demonstrate novel concepts for detecting, localizing, and classifying targets with arrays of low-cost, miniature, internetted, unattended magnetic ground and littoral sensor systems.

DESCRIPTION: Research and development leading to the design and demonstration of novel, advanced, unattended magnetic and chemical sensor systems for the detection, localization, and classification of ground and shallow water time critical targets are required. Efforts may address individual miniature magnetic and chemical sensor systems, however, multi-sensor magnetic and chemical systems with local signal processing, data fusion, and an internetted communications capability, are also of interest. Low-power, autonomous wake-up and commanded wake-up capabilities for these unattended magnetic and chemical systems are required. Efforts of interest also include low-power, extended life, high resolution, efficient real-time feature based classifiers; models for real-time transformation of sparse sensed magnetic dipole data to predictions of threat vehicle or threat human related parameters; and decision aids to enable optimum configuration and processing of data from magnetic sensor arrays. Parameters of interest that will be utilized to evaluate proposed magnetic and chemical sensor concepts are projected cost; size; weight; reconfigurability through modular design; power consumption; covert operations; and detection, localization and classification performance. Aggregate metrics, such as dollars-per-kilometer-squared detection coverage-hours of life without battery change, will be utilized to compare proposed concepts.

PHASE I: Develop concept description and initial design of a magnetic and chemical sensor related system with clear description and quantification of key predicted performance parameters. A sensitivity analysis that indicates the predicted performance of alternate proposed system configurations, including identification of highest risk aspects of the proposed design, is also required. Risk mitigation demonstrations and/or simulations of key high risk aspects of the proposed design, to demonstrate proof-of-concept, is also required.

PHASE II: Final design and demonstration of the proposed magnetic and chemical sensor related system, with post-demonstration analysis sufficient to demonstrate proof-of-performance for the proposed system is required. Complete design and demonstration documentation must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of a low-cost, high-performance, modular, miniature sensor will expand the commercial markets for home and industrial security systems, industrial process monitoring systems, and environmental monitoring systems. Increased performance; component modularity for optimum domain specific tailoring of sensor configurations; and the dramatic reduction in size, weight, and cost of these sensor systems will increase the range of potential applications for these products.

REFERENCES:
Internetted Unattended Ground Sensor System Description Document, 1995.

DARPA ST98-007 TITLE: Universal, Windows Based, High Speed Data Acquisition and Control Graphical User Interface System

CRITICAL TECHNOLOGIES AREA: Computing and Software

OBJECTIVE: To take full advantage of state-of-the-art, high speed data acquisition and control hardware by developing a Windows based, modular, universal, high speed, multi-channel data acquisition and control graphical user interface (GUI).

DESCRIPTION: High speed, long duration, and multi-channel data acquisition and control systems require the use of custom coded, DOS based programming. Recently, there has been an industry-wide push toward creating universal hardware components that conform to a VXI bus standard. This universality enables the data acquisition user to configure boards from many different vendors into a complete, comprehensive data acquisition and control system. Unfortunately, the software that is used for control of this hardware, if Windows based, is relatively slow and machine overhead intensive. Therefore, many programmers are forced to write custom code to control these VXI devices to perform highly complex tasks. This task is both time consuming and unproductive, as this custom code is generally very specific and can only be used for a specific task.

The goal of this topic is to produce a generic, windows based data acquisition and control graphical user interface and hardware system that is capable of multi-channel, high speed data acquisition with real-time display of processes and variables. The system should be capable of at least 100 channels of data at up to 1000 samples of data per channel, per second, for at least ten minutes. A comprehensive control system should be able to control up to 50 processes in either open or closed loop, with a finite, measurable control loop speed that is less than 10% of the data acquisition sample rate. The software system would be a 32 bit Windows based system, with either numerical or graphical depictions of the data values and control processes. The control equations and algorithms would have to be user modifiable.

Phase I: Demonstrate a basic, integrated graphical user interface consisting of both hardware and software with all modules active, including data acquisition, control, real-time display, graphical user interface, and software capable calibration of amplifiers. Although the Phase I system will not include all of the hardware or software to drive all of the channels, it should be capable of a significant and demonstrable portion of the overall effort, and should run at rated speed. Hardware deliverables at the conclusion of Phase I would include a VXI bus system of at least 25 data channels and 10 control channels. Software deliverables would include a working Windows based Graphical User Interface with customizable A/D and D/A modules. The software would demonstrate accuracy of process control, control loop speed, data acquisition with mass storage capability, basic data reduction, and reporting.

PHASE II: Demonstrate and deliver a fully operational GUI and VXI bus that demonstrates full capability of at least 100 channels of data at 1000 samples/sec, with a control loop speed less than 10% of the data acquisition sample rate. The system should have a fully customizable interface with absolute crash protection. Self checks in the software would make the misconfiguration of the software impossible. The software would have a self diagnostic module which would check all of the hardware components of the system. The hardware deliverables would include a full up VXI chassis, with all of the hardware channels active, and capable of full speed operation. The software should be capable of automatic calibration of A/D channels, including pressure, temperature, and strain. The graphical interface would allow seamless navigation from acquisition, control, data reduction, calibration, and reporting software modules.

PHASE III DUAL USE APPLICATIONS: A truly universal, modular, high speed data acquisition and control system has a tremendous amount of commercial application. Computer control is used in every major commercial manufacturing, testing, and evaluation industry. The system could be used to control any mechanically regulated device - from freezers to fire alarms to building security systems. Automobile manufacturers could use the GUI for assembly line process control and quality assurance programs.

REFERENCES:

1) "1996 Instrumentation Reference," National Instruments, Austin, Tx. 1996.
2) "1997 Test Systems Handbook," Hewlett Packard, Santa Clara, Ca. 1997.

BALLISTIC MISSILE DEFENSE ORGANIZATION (BMDO)
SMALL BUSINESS TECHNOLOGY TRANSFER PROGRAM
Submitting Proposals - 1998 Instructions

Send Phase I proposal packages (the unbound original, to make extra copies, and six bound copies, to immediately forward to evaluators, of the full proposal, PLUS one additional copy of Appendices A and B only) by US mail (or any commercial delivery service). Also, APPENDIX E needs only to be included with the unbound original. DO NOT attach APPENDIX E to the six bound copies. The mailing address follows and the BMDO SBIR website address is provided.

Ballistic Missile Defense Organization
ATTN: TOI/SBIR(BOND)
1725 Jefferson Davis Highway, Suite 809
Arlington, VA 22202

For Administrative HELP ONLY call: 800-937-3150 or 800-WIN-BMDO
Internet Access: www.futron.com/bmdo/sbir.html

Proposals delivered by other means will not be accepted. Proposals received after the closing date will not be processed. BMDO will acknowledge receipt of proposals IF AND ONLY IF the proposal includes a self-addressed stamped envelope and a form that needs only a signature by BMDO.

All proposal submission appendices may be downloaded from the DoD SBIR/STTR Website at (http://www.acq.osd.mil/sadbu/sbir/sttrappx.htm). Furthermore, all companies are strongly encouraged to upload their APPENDIX A and APPENDIX B only, through the BMDO SBIR/STTR Website at (http://www.futron.com/bmdo/sbir.html). Uploading the two appendices will allow BMDO to process proposals faster so that evaluations can be received quickly. It is in a companies best interest to upload their APPENDIX A and APPENDIX B since those proposals will be processed first.

BMDO is working toward providing a ballistic missile defense system and developing a technology base that will allow the Department of Defense to protect the warfighters against increasingly sophisticated and lethal missiles around the world. BMDO accomplishes these efforts through three broad mission focus areas: Theater Missile Defense (TMD), National Missile Defense (NMD), and Advanced Technology Developments (ATD).

TMD systems respond to and protect U.S. forces, allies, and other countries from existing and emerging short to medium range threat missiles. Three core programs represent the bulk of BMDO investments: PATRIOT Advanced Capability-3 (PAC-3), Navy Area Defense, and Theater High-Altitude Area Defense System (THAAD). NMD is concerned with the possibility of a limited ballistic missile strike against the homeland. The key component systems currently under consideration include: ground-based interceptors; ground-based radars; upgraded early-warning radars; battle management, command, control, and communications (BMC3); and advanced sensor technology developments. Finally, BMDO depends on advanced technology developments, of all aspects, to invigorate its ability to implement both TMD and NMD systems in response to increasingly sophisticated ballistic missile threats, to include cruise missiles. Therefore, the continued availability of such advanced technology developments has become an increasingly vital and critical element of the overall BMDO mission.

The intent of BMDO, first and foremost, is to seek out the most innovative technology that might enable a defense against a missile in flight -- lighter, faster, stronger, more reliable technologies are all of interest. Proposing companies need not know specific details or requirements of possible BMDO systems, research and development goals, or specific technology needs or specifications, but must understand that potential technologies should have application to ballistic missile defense at some level. (A better fire extinguisher, although it may be innovative and there is a commercial market, does not support ballistic missile defense requirements at any level.)

Specifically, BMDO seeks to invest seed-capital, which supplements private sector investment support, in a product with a future market potential (preferably private sector) and a measurable BMDO benefit. The BMDO SBIR/STTR Program will neither support nor further develop concepts already mature enough to compete for private capital or for mainline government research and development funds. BMDO prefers projects which move technology from the non-profit institution into the private sector market through a market-oriented small company. Phase I proposals should focus on the innovation of the proposed technology, it should illustrate the concept feasibility, and the merit of a Phase II for a prototype or at the very least a proof-of-concept. Phase II competition will also be judged intensely on future market possibilities and commercialization potential. Phase II proposals may be submitted to BMDO anytime, for any amount, in any format after the Phase I begins. Unique efforts showing time sensitivity or submitted for FasTrack will be given due consideration for Phase II start-up funding and Phase I proposals may include a post-Phase I optional tasking that will permit rapid start-up if the Phase II or FasTrack application is approved. The latest information on how BMDO implements its FasTrack Program may be found at the website address under the Frequently Asked Questions (FAQs) section.

Principal Investigators who are tenured faculty are NOT considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR or STTR contract; any waiver must be requested explicitly with a justification showing a compelling rational and national need; BMDO expects to grant no such waivers.

BMDO intends for a Phase I to be only an examination of the merit of the concept or technology with an average cost under $65,000. Although proposed cost will not affect selection for negotiation, contracting may be delayed if BMDO reduces the proposed cost. DO NOT submit the same proposal, or variations thereof, to more than one BMDO topic area; each idea will be judged once in an open competition among all proposals. Furthermore, BMDO performs numerous cross-reference checks within each solicitation.

Because BMDO seeks the best nation-wide experts in innovative technology, proposing comapnies may suggest technical government reviewers by enclosing a cover letter with the name, organization, address, phone number, and rationale for each suggestion. BMDO promises only to consider the suggestion and reserves the right to solicit other evaluations.

Ballistic Missile Defense Organization 1998 STTR Topics

BMDO98T-001 - Sensors

BMDO98T-002 - Electronics and Photonics

BMDO98T-003 - Surprises and Opportunities

BMDO FY98 STTR TOPIC DESCRIPTIONS

BMDO 98T-001 TITLE: SENSORS

Introduction: BMDO investigates various sensor technologies for both TMD and NMD applications. As such, a significant investment is made each year in the continued development of increasingly robust and sophisticated sensor systems which may eventually find their utilization in a ballistic missile acquisition system. All areas of the electromagnetic spectrum provide potential avenues toward finding and disabling a ballistic missile in flight. Furthermore, sensor systems, components, sub-components, and piece part specifics are constantly under evaluation by the various TMD and NMD elements for replacement by the latest technology developments from industry.

Description: Sensors and their associated systems/sub-systems will function as the "eyes and ears" for ballistic missile defense applications, providing early warning of attack, target detection/classification/identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional and innovative techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from backgrounds, debris, decoys and other penetration aids are specifically sought. Sensor-related device technology is also needed. Examples of some of the technology specific areas are: cryogenic coolers (open and closed systems), cryogenic heat transfer, superconducting focal plane detector arrays (for both the IR and sub-mm spectral regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering, range-doppler lidar and radar, passive focal plane imaging (long-wavelength infrared to ultra-violet; novel information processing to maximize resolution while minimizing detector element densities), interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based ballistic missile defense applications (uv-sub-mm wave), new optics and optical materials. Entirely new and high-risk approaches are also sought.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company G, with commercial sales of $15M+, is noted for its laser diode pumped q-switched solid state laser products. Company H, with a market cap of $24M+, transferred its microwave based infrared detector and superconducting millimeter wave mixer technologies for a variety of cryogenic systems and products. Company I's high power laser array transmitters are utilized on future military satellites for communications.

BMDO 98T-002 TITLE: ELECTRONICS AND PHOTONICS

Introduction: In implementing its TMD and NMD program activities, BMDO is continuing its developments of such efforts as the PATRIOT Advanced Capability-3 (PAC-3) missile system which has four major systems components: radar, engagement control station, launching station, and interceptors. The Navy Area Wide system will develop a sea-based capability that builds upon the existing AEGIS/Standard Missile air defense system. This system is based on the AEGIS-class cruisers and destroyers, which provide all elements of missile defense and are particularly suited to protecting forces moving inland from the sea. The Theater High-Altitude Area Defense System (THAAD) system will form the largest umbrella of missile protection in a specific theater, arching over all other missile defense systems. THAAD consists of four major systems components: truck-mounted launchers; interceptors; radar system; and battle management, command, control, communications, and intelligence (BMC3I). These increasingly sophisticated systems will provide the opportunity to destroy short and medium range ballistic missiles and other threats in the atmosphere far enough away that falling debris will not endanger friendly forces..

Description: The necessary advances in electronics for the many ballistic missile defense applications will require advances in electronics materials. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/superlattice structures which allow the realization of unique elective properties through "band gap engineering" are sought as are new organic and polymer materials with unique electronic characteristics. In addition, exploitation of the unusual electronic properties of gallium nitride is of considerable interest. Among the many BMDO electronic needs and interest are advances in high frequency transistor structures, solid state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitors, single-electron transistors, metallization methods for repair of conducting paths in polyceramic systems, and sol-gel processing for packaging materials.

Also, dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to: high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. Non-linear optical materials advancements and new bistable optical device configurations are of interest.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company Y, with a market cap of $210M+, commercialized technology that allowed for the delivery of ultra-pure materials to semiconductor thin film reactors. Company Z, with a market cap of $14M+, manufactures radiation detection devices and was funded for avalanche photodiode arrays. Company AA, with a market cap of $97M+, has a substantial market share of the atomic layer epitaxy growth method of semiconductor compound materials based on efforts funded under this topic. Company BB, with a market cap of $155M+, which manufactures flat panel display devices, received some initial funding for their silicon-on-insulator films and organometallic chemical vapor deposition technology developments. Company CC, with a market cap of $200M+, commercialized technology based on degradation resistant laser diodes. Company DD, with a market cap of $14M+, is in the process of commercializing technology based on its surge suppression devices. Company EE, with a market cap of $265M+, had initial funding for its high bandgap compounds and laser diode products to develop a number of commercial and military products. Company KK established a multilayer coating technology that can be easily transported to any location for application. Company FF developed a magnetoresistive non-volatile random access memory chip which is also radiation hardened and is utilized in a number of space applications for the military and commercial sectors. Company R took a unique technology approach in addressing fiber-optic and other optical communications applications to both the military and commercial industry. Company S is providing a low-loss electro-optical switching array, Company T is providing optical bus extenders and fiber-optic modulators, Company U has funded technology which utilized wavelength division multiplexing techniques; all to support the ever growing optical communication industry.

BMDO 98T-003 TITLE : SURPRISES AND OPPORTUNITIES

Introduction: BMDO increasingly depends on advanced technology developments, of all kinds, to invigorate its ability to find and disable missiles in flight and to defend against an increasingly sophisticated threat, to include cruise missiles. Therefore, the continued availability of emerging technology has become a vital part of its mission. BMDO has specific programs which pursue speculative, high-risk technologies that could spur a revolutionary leap in ballistic missile defense capability. Specific goals include, but are not limited to: quickening the pace of technology and innovation developments and decreasing the time required to transform scientific breakthroughs into actual applications.

Description: Since ballistic missile defense is an exploration at technology's leading edge to begin with, it recognizes that surprises and opportunities may arise from creative and innovative minds. BMDO will consider proposals in other technologies where they present a completely unique and unusual opportunity for ballistic missile defense applications. The proposing company should take special care to describe the specific technology in complete detail and specify why ballistic missile defense applications would benefit from exploring its unique and novel implications. Proposing companies should make special note that proposals in this topic will receive preliminary screening at BMDO and that they may be rejected as too far afield without the benefit of a full technical review received by proposals in the topics already listed. It is recommended that the proposing company focuses their submission toward one of the specific outlined topics above unless the technology proposed is truly an unquestionable innovation. This full and open call is for new/novel/innovative/unique advanced technology developments, and not for the recycling of old ideas, incremental advancements, or questionable improvements.

Successful Phase 3/Dual-Use Commercializers (Real-World Examples): Company JJ, with a market cap of $740M+ (The largest of any BMDO SBIR/STTR recipient.), was funded for technology to further its intelligent client-server software solutions for mission-critical decision applications in real-time military and commercial environments.

Any potential new development may address a DoD Critical Technology Area from this topic, provided it supports BMDO mission interest at some level. DoD Key Technology Areas:

#1 - Aerospace Propulsion and Power
#2 - Air Vehicles/Space Vehicles
#3 - Battlespace Environments
#7 - Command, Control and Communications
#8 - Computing and Software
#9 - Conventional Weapons
#10-Electronics
#11-Electronic Warfare/Directed Energy Weapons
#13-Human Systems Interface
#14-Manpower, Personnel and Training
#15-Materials, Processes and Structures
#16-Sensors
#17-Surface/Under Surface/Ground Vehicles
#18-Manufacturing Sciences and Technology
#19-Modeling and Simulation